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SOILS, CHEMICALS, IRRIGATION, ENGINEERING AND ECONOMICS

A Howard Rotavator 'Gem' dealing with Lallang in Siam

VOLUME 4, No. 11 NOVEMBER 1952

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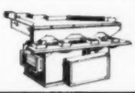

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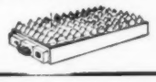

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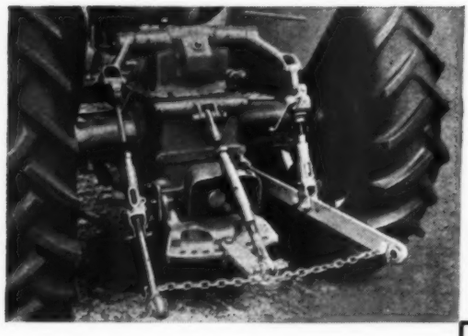

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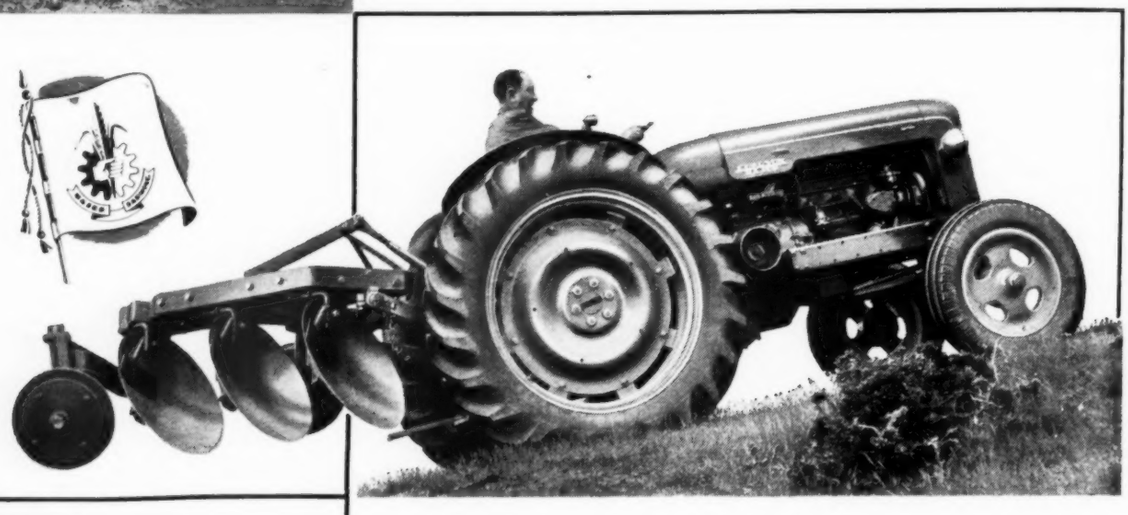

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Editorial Comment

East African enquiry

THE announcement on September 24 by the Rt. Hon. Mr. Oliver Lyttelton, Secretary of State for the Colonies, that it is proposed to set up a Royal Commission to enquire into 'the wider aspects of land use in relation to the economic, industrial, social and demographic problems of the East African region,' is important. Recently, increasing attention has been directed to events in this part of the world and to the growing unrest among African circles that has become so manifest of recent years.

In *The Times* of September 24 and 25 there appeared two articles from the pen of Sir Philip Mitchell, who until recently held the office of Governor of Kenya, in which he analyses some aspects of the position and assesses the problems which the Commission will have to face. Sir Philip has himself rendered notable service to the cause of administration in East Africa during the past eight years as Governor of Kenya, earlier as Governor of Uganda and earlier still as Secretary for Native Affairs in Tanganyika. He possesses an unrivalled knowledge of the difficulties and problems and it seems a justifiable surmise that his views in this regard may have possessed great weight in influencing the Secretary of State to arrive at a decision.

The effects of change

THE changes which have occurred in much of East Africa are as remarkable for their magnitude as for the relative suddenness with which they have happened. Sixty years ago, that is well within the lifetime of many people today, much of East Africa was an unknown and to a large extent unexplored territory; the exploits of Livingstone, Stanley and others in opening up the unprobed lands of the dark continent were recent events, and where Nairobi now stands, a city of 140,000 inhabitants, there was nothing but an uninhabited plain.

Native African life was of the most primitive description —red in tooth and claw; tribal numbers were prevented from growing unduly by the periodic inroads of famine and pestilence, to say nothing of the warlike incursions of neighbouring unfriendly tribes, the attacks of wild beasts or the raids of slaving parties from the coast. Such agriculture as existed was subsistence shifting cultivation and there was abundance of land for all. It was life at a very low level, it is true, but it was stable; it had gone on for many thousands of years and could continue along those lines indefinitely, provided nothing occurred which disturbed the existing balance.

The discoveries of the East African explorers were followed by the arrival of Europeans from various powers bent on developing the country, enhanced and reinforced by strong missionary zeal among the European nations which could not endure the tales of horror brought back by the explorers and were intent on improving the lives and lots of the people they regarded as unfortunate and benighted savages.

Thus, under these influences penetration by the European nations occurred, population checks were alleviated or removed, numbers grew and conditions improved beyond all knowledge, communications were established and journeys which formerly took weeks and months could be accomplished in hours or even minutes, thanks to the railway and the aeroplane. Europeans had taken possession of parts of the land and introduced new crops and new methods. It cannot be said that this was done at the expense of the African, for much of the land was untouched and never could have been touched had the ordering of matters been left to the indigenous tribes.

The dilemma is that the European in his penetrations has created new and unforeseen conditions, which in due course are undoubtedly likely to overwhelm himself and the descendants of the original African tribes who occupied the land before his incursion.

Elspeth Huxley has defined the position, when in a recent book she likened it to that created by the sorceror's apprentice who by means of a magic formula raised a spirit which, being commanded to carry buckets of water, could not be laid owing to the luckless apprentice having omitted to find out the appropriate formula to stop the spirit's antics.

Let us hope that when the proposed Royal Commission has been appointed it may ultimately discover a formula which will permanently lay the spirit which unintentionally and unwittingly the European has raised in Africa, and which will enable all races to work together to achieve a future in which the claims of all will be taken into account and peaceful expansion and improvement be achieved.

The British Association

THE British Association this year met in Belfast, its last visit to that city having been paid 50 years ago in 1902 when the president was the late Sir James Dewar, famous for his work on the liquefaction of gases.

This year the president was Professor A. V. Hill, F.R.S., who in his presidential address devoted himself to the consideration of the intriguing question, 'has science on balance proved itself of benefit to mankind?' In fact, the mood of searching self-examination seems to have been rather characteristic of the deliberations of the meeting as a whole on this occasion. To most of the members it must indeed have been apparent that, while scientific discoveries during the past 100 years have indeed increased the chances of human survival, there is at present an unending race going on between the population increases which are occurring as the result of the influence of scientific discovery on human affairs, and the rate at which the increased food supplies necessary to support these multiplying millions can be produced.

Professor Hill did well to stress one particular aspect, namely that once the individual scientist is detached from his own particular preoccupations he differs in no noticeable respect from his fellow human beings; he is, in fact, just as liable to be influenced and acted upon by political creeds and propaganda and to be swayed by emotions as many others. As Professor Hill himself put it, ' in their particular scientific jobs scientists have developed a faculty of critical examination, but this does not save them from wishful thinking in ordinary affairs or even from misrepresentation or falsehood when their emotions or prejudices are strongly enough moved.'

Population and food supplies

AFTER all is said and done it cannot be denied that at whatever stage we have at present arrived in the race between human increase and food production, if the process is continued indefinitely a time must ultimately come sooner or later when in the last resort population increase must outstrip food production, if for no other reason than that in Utopian conditions all the land that is capable of being used for that purpose is being used and that with maximum efficiency. Moreover, possibilities are unveiling themselves of producing food by what may be termed synthetic chemical or biological processes. As, for example, by the use of torulae or algae to produce foodstuffs. Who can say what are the limits to possibilities in these directions, but also who would dare to say that they are capable of indefinite exploitation and that ultimately a period will not be put to these possibilities? While in the last resort there remains the limiting factor of room, and we cannot eliminate the possibility that ultimately a limit will be put to human expansion simply by the fact that there literally is not room for any more. The conductor will have rung the bell three times and no more can be taken on the bus.

It is the earnest hope of all that before this time will have arrived the lesson will have been learned that mankind must limit its increase rate commensurately with its ability to produce food enough to support itself. It is not sufficient just to assume that, because so far in the world's history problems of this type have provided their own solution, they will always do so. With Professor Hill one can but wonder at the Indian Planning Commission which, after courageously facing the facts concerning the problem of increasing population pressure and the production of adequate supplies, not only of food but also of the other needs of daily life in the great Dominion, comes to the conclusion that such matters must be left to God.

To Professor Hill a considerable debt of gratitude is due for having so clearly and so starkly posed these vital questions. On the answers the future of the world must depend. It is true that at present no reassuring answer is yet in sight, but it is at least something to have the problem clearly posed.

The Grasslands Congress

DURING the past six weeks a number of other important conferences have also taken place in various parts of the world. Thus, in the U.S.A. there has been held the sixth International Grasslands Congress under the auspices of the United States Department of Agriculture and the Food and Agriculture Organisation of the United Nations. This was a major effort to which months of preliminary preparation had been devoted. The undoubted success which it achieved must be held as a tribute to the importance grass plays in the economy of food production and the conservation of natural recources on land and water throughout the world, and the extent which these have become recognised.

As Dr. F. T. Wahlen, Chief of the Agriculture Division of FAO, pointed out in a paper read to a plenary session of the Congress, ' the widespread interest in the conservation of natural resources and the energetic measures taken by many Governments are hopeful signs that the wholesale destruction brought about by indiscriminate grazing in the " Pioneer Fringe " has taught us a lesson that will not be forgotten . . . The misuse of natural grasslands has been one of the most powerful agents of soil destruction in history, more particularly during the past 100 years.'

The natural grasslands of many parts of the world, especially the tropical and subtropical aspects, have great points of similarity; in northern Latin America, in the American midwest, in Australia and in parts of Africa all have been invaded by man during the past 100 years. In the early days it was not realised how fragile was the ecological balance and how very vulnerable the climax association. As a result of reckless exploitation, too often the equilibrium has been upset without hope of re-establishing the balance by economically feasible means.

Let us hope that the Congress will prove the forerunner of effective collaboration in the improvement and development of pasture and forage resources in many countries under the auspices of FAO, in association with the regional agricultural authorities.

Tractor statistics

SINCE 1938 the world output of tractors has increased from less than a quarter of a million to nearly one million annually during the period 1948-50. A recent publication of the Commonwealth Economic Committee,* reviewed on another page, gives us statistics of this production, of the main exporting and importing countries, and details of the agricultural machinery trade throughout the world in general and the Commonwealth in particular.

In 1950 the United States remained by far the largest tractor producer with 70% of the total world production. The United Kingdom manufactured 15%, and Canada, Germany and France the bulk of the remainder. The estimated world production of tractors in 1950 was 989,048.

Since the war 60% of the world tractor exports have been from America, compared with 85% pre-war. This proportional drop has been due to the increasing tendency of many countries to manufacture their own machinery or import it from non-dollar sources. Meanwhile, the United Kingdom has expanded her exports to nearly 25% of the total, while Germany, France and Italy have also shown increases.

* A Survey of the Trade in Agricultural Machinery. 36th Report of the Commonwealth Economic Committee. H.M.S.O., 1952.

Where do these increased exports go? According to the figures for 1951, £42.6 million worth went to Canada, followed by Australia with £18.6 million worth; there is then a big drop down to £8.5 million for Turkey, £6.2 million for the United States and £5.9 million for India. The Union of South Africa has also become a major importer of agricultural implements as well as tractors, the figure for the two items together being £12.1 million for the same year (1951).

In terms of numbers, total trade in tractors has increased to between four and five times the pre-war level. Thus, it may be seen that considerable progress has been made on much of the world's surface towards expanding agricultural output by increasing mechanical power. Technically and economically there is scope for much more and with the growing cost of labour in most countries further advances should be ensured for many years to come.

Development costs

THE series of articles we have published during the past year under the title 'Industry's Contribution to Agricultural Research' will already have shown that considerable expenditure is required in developing new chemicals for insect, disease, or weed control, which must be faced before there is any hope of return through the sale of the products. It is easy enough to argue that in the end all research pays, but there is a limit to the amount of bread that any company, however progressive, can afford to cast upon the waters of the future. At the end of a decade during which new agricultural chemicals have been developed at an unprecedented rate, there are signs that research and development costs are being carefully examined. This non-glamorous aspect of research has been lately surveyed in a recent U.S. article (R. H. Wellman, *Agricultural Chemicals*, 1952, **7**, 32-34, etc.). The figures there given for research and development costs will probably astound even knowledgeable agriculturists.

The earliest stages are generally cheap enough. Thus, synthesis and initial screening are assessed at as little as £130; but only 1 in 30 tested chemicals pass beyond this stage so 30 times this initial cost must be charged against the ultimately successful product, *i.e.* £3,900. Further laboratory and pot-test work may cost another £360; this is a stage which is passed by 1 in 10 so here £3,600 must be assessed against any finally successful chemical. But the tenfold multiplication must also be applied to the earlier cost of £3,900; so the total costs at this stage reach the figure of £42,600. Initial field tests will cost about £320; 1 in 3 chemicals may pass this point so by now the accumulated investment has reached £128,750. Next comes the company development stage, involving the investigation of larger-scale production and distribution—the average cost of this is given as a little under £100,000. It is considered that one in two chemicals emerge successfully from this examination. By then, therefore, something in the order of £450,000 is involved. To this must be added the costs of further development work in association with official research stations and seeking government approval. £500,000 is a round indication of the costs of developing a new agricultural chemical when, quite properly, the costs of wayside failures are also charged against the successes. Finally, when the successful product seems to possess a sound future, the company concerned must be prepared to make larger investments still in full-scale production plant and distribution facilities.

One conclusion may be drawn—development costs can be appreciably reduced inasmuch as the unlikely products are rapidly assessed as failures. Certainly over-optimistic appraisement of chemicals under test could be a costly liability.

World fertiliser trade

THIS issue contains an article entitled 'The Future of Phosphates,' by Mr. D. P. Hopkins, and apropos of this we have recently received from the Agriculture Division of FAO a new report on current world production and consumption of fertilisers. In this publication the figures given refer to the three-year period 1950-51 to 1952-53; thus the figures for the last two years are necessarily estimates, owing to the publication date of the report (August 1952).

According to this report the total world production of nitrogen, phosphoric acid and potash in 1950-51 was 14,282,014 tons, and in 1951-52, 14,988,342 tons, an increase of 4.9%. Consumption during these two years was 13,778,335 tons and 14,472,410 tons, respectively. The outlook for the present 1952-53 year is for a further increase of 7.1% of total world production and an increase of 8.6% of total consumption.

These increasing consumption figures are very encouraging; for instance, taking some of the areas which have shown particularly striking advances, in Africa nitrogen consumption increased by 124% in 1951-52, and in Oceania and Asia potash consumption increased by 53% and 35%, respectively, during the same year. There is, however, some anxiety whether, as time goes on, the supply can keep pace with the increasing demand for the three main plant nutrients, particularly phosphate. An adequate supply of the latter is necessary to enable the greater increases of nitrogen and potash supplies to be used to full advantage in a balanced manurial programme.

In order to maintain and improve supplies it is now becoming increasingly necessary to look for new sources of raw material, such as high-grade phosphate rock in Asia and South America, and to improve present techniques of extracting the plant nutrients from raw material.

It would be a great pity if supplies failed just at the time when many of the more backward countries are becoming 'fertiliser-minded' after much patient rural education and extension work, and it is to be hoped that the maximum amount of technical skill can be applied to this problem of possible shortage. Already the search for suitable raw materials and their successful utilisation as fertilisers has produced some results; in Kenya 'soda-phosphate' (18% citrate soluble P_2O_5) is being produced on an ever-increasing scale and in Taiwan (Formosa) phosphoric acid production has been increased in the forms of superphosphate and also as a new product, serpentine fused phosphate. Meanwhile, the search continues.

Ultrasonic vibrations and insect control

A RECENT enquiry from a correspondent prompts some remarks on ultrasonics. Our correspondent drew attention to an article in *Chambers' Journal* which discussed recent advances in the use of high-frequency sound waves and asked whether the ultrasonic principle had been applied to the destruction of field pests of cotton, notably to Pink Bollworm (*Gelechia gossypiella*).

On enquiry with the Imperial Institute of Entomology we found that, while possibilities in this direction apparently exist, it is safe to say that such waves have not so far been used for this purpose on a field scale.

It appears that experiments with the fruit fly (*Drosophilla melanogaster*) have shown that ultrasonic vibrations are effective in destroying these insects in the early stages of growth, while there are also experimental indications that ultrasonic vibrations may have some application in the destruction of insects in stored grain. It is also reported that they may have efficacy in destroying insects attacking tobacco.

It appears that research in the application of ultrasonics is actively being pursued, but that it is as yet too early to say what the prospects may be.

Certainly, however, it is intriguing to conjure up a picture of the future farmer, when he observes the first signs of the appearance of this or that insect pest on a crop, immediately turning on his ultrasonic whistle or siren, after which the offending insects will forthwith curl up and die.

Rice in the East

ON many occasions we have referred in these columns to the vast importance which attaches to rice supplies in the East, in relation to the maintenance of world peace.

The late war and the events which have succeeded it have largely disrupted rice supplies and despite the efforts to amend a precarious situation these supplies are still far from equating with demand, especially bearing in mind the large increases in population which have occurred in most Eastern countries of late years.

Much attention has been devoted to this matter, and in a recently issued communique FAO records that at present the outlook in this regard, instead of improving, is showing unfavourable features. At present the total quantity of rice that enters world trade is of the order of 4,800,000 tons per annum in place of the 8,000,000 tons which went into the open market before the war.

Professor G. C. Allen, of University College, London, who has recently discussed the problems of rice shortages before the Committee on Commodity Problems of FAO, has pointed out that the wartime destruction of transport equipment, the demolition or damage of irrigation works, the depletion of farm capital and the political unrest which has prevailed in many countries, have taken heavy toil of rice production, while conditions today lack the necessary promise of security to encourage people to undertake reconstruction.

Moreover, political idealism in many countries where the effect of basic economic conditions in their local political setting may not be properly understood have induced widespread territorial changes, accompanied by political unrest, and have led to the administrative disintegration of large regions which formerly enjoyed peaceful and productive economies under a single unified regime.

The outlook

THE present situation unfortunately appears to be showing no sign of improvement. Whatever the causes may be the Ceylon Government, for example, recently recorded that the present discrepancy between the demand for and the supply of rice is more accentuated this year than in any year since the end of the war.

In past years the East has to some extent made up for rice shortages by imports of wheat from western lands, but these consume ever-shortening supplies of dollar currency while in any case wheat is not an acceptable substitute for rice for the great mass of rice-eating people in the East. One of the most serious consequences of the shortage is the soaring price of rice, which is now almost £20 per ton dearer than wheat flour. It cannot be gainsaid that this amazing discrepancy can have a most deleterious effect in the rice deficit countries.

No one can deny that in certain directions strenuous efforts have been made to attempt to deal with some of the causes of the present threatening situation and to provide a measure of relief. The International Rice Commission of FAO has done very valuable work within the confines of the programme by which its activities are prescribed. Its working parties on rice breeding and on fertilisers for rice are amassing stores of technical information which should be invaluable once conditions supervene which can permit of their being applied on a scale sufficiently wide to have a sensible effect.

The Colombo Plan contains numbers of large-scale schemes for the improvement and extension of rice growing which, if and when they are implemented, should help to produce more rice; although even if they are fully implemented they can do little more than help to meet for a time the demands of ever-increasing populations.

The difficulties are man-made and arise from the inability to resolve political difficulties, due to conflicting ideologies and aspirations, many of them hopelessly unattainable, and to evolve a system of exchange which meets human requirements and allows the free exchange of commodities as and when the natural demand arises. It would indeed be a tragedy if after two wars and the succeeding welter of discussion and planning in which mankind is now involved, the ultimate result should be the shipwreck of his hopes and the disintegration of the schemes and plans for world betterment which have been proliferated of late years.

It is regretted that in our September issue, under Editorial Comment, Professor P. N. Driver, of Poona College of Agriculture, was wrongly referred to as Professor F. N. Driver.

The Future of Phosphates

D. P. HOPKINS, B.Sc., F.R.I.C.

The future of phosphatic fertiliser supplies must be regarded as one of the major agricultural problems facing cultivators. The shortage of sulphur, leading to shortages of sulphuric acid essential for the manufacture of superphosphate under present-day conditions, has created a difficult position. In this authoritative article the author reviews the various aspects of the problem and considers the alternatives.

IT is not an accident of history that the modern fertiliser industry began tentatively with ground bones and then found a firm basis with Lawes' development of superphosphate. The rapid progress in the 1840s would not have been possible if the first so-called ' artificial ' fertiliser had not provided the most decisive plant nutrient, phosphorus. Purists may object to the view that any one of the essential elements, major or micro-, is more influential than the rest, but in practice facts support it. All the essential nutrients may be likened to keys on a ring, but the phosphatic key must be inserted into the lock first. A phosphorus-hungry seedling will have a stunted and slowly growing root system and will be unable to make effective use of other nutrients, even though these may be abundantly present. A phosphorus-satisfied seedling will develop a strong root system and will be able to make full use of supplies of other nutrients. To this must be added the fact that phosphate deficiency is the most frequently encountered plant-food problem.

Future supplies

One of the biggest problems is the future supply and cost of phosphatic fertilisers. Cost is perhaps the crux of the problem, for if cost did not matter there would be no supply difficulty. For the past 110 years agriculture has been able to obtain phosphatic fertilisers at less than their real cost of production, and it has been possible to provide much of the tonnage required from processes based upon cheap by-products of other industries. This situation has, however, been steadily changing since 1939. On the one hand, the growth of populations and the need for better standards of nutrition have increased the demand for fertilisers; on the other, the supply of *cheap* by-products is contracting. Yet nothing could be more disastrous than for farmers to reduce their use of phosphatic fertilisers because they seem too dear or too scarce. The problem is economic, but its solution must be technological. It is largely in the hands of chemists and engineers and if they cannot succeed in preserving relatively cheap phosphates food production must become more costly.

Although superphosphate began with bones as the source of phosphorus, it rapidly became obvious that the supply of bones could not meet even the early demand for phosphatic fertilisers. Lawes' acid treatment was soon shifted from bones to mineral phosphates and this second type of superphosphate was found to be just as effective. Ever since, a steadily increasing number of deposits of mineral phosphate has been found.

Store for single and triple superphosphate in bulk

Availability

Why, then, is there a problem? It arises from the fact that mineral phosphate is not in general ' available,' the phosphorus being chemically locked up in a complex molecular form. It is wrong to regard mineral phosphate as calcium phosphate. What we call rock phosphate is really a fluorophosphate of calcium; millions of years ago it was indeed a simple calcium phosphate deposited from the biological cycle of life, but the element fluorine has since invaded the molecules and this geological-chemical change has altered the nature of the material. Calcium phosphate will become slowly available in soils; though it is insoluble in water, soil acids slowly dissolve it. But the complex fluorophosphate is much more resistant. To convert it into a readily available form, treatment that breaks up the complex molecules and drives out the fluorine is required. It is only a half-truth to say that rock phosphate is made available by dissolving it in sulphuric acid. The crux of the process is that the acid treatment breaks up the fluorophosphate molecules into simpler ones and causes the simultaneous removal of much of the fluorine. The fact that the final form is mainly water-soluble mono-calcium phosphate is only part of the story.

The superphosphate process

So long as sulphuric acid was plentiful and cheap, the superphosphate process was an ideal method for turning difficultly available rock phosphate into readily available phosphatic fertiliser and for many decades this was so. It has been a by-product from other major chemical processes, at times in surplus amounts, and between the wars superphosphate was in some countries a ' vehicle ' for surplus acid, to be ' dumped ' on the international market at low prices. In the past 20 years, however, this situation has gradually changed; new industrial processes, *e.g.* artificial fibres, have created a bigger

demand for sulphuric acid and this, together with the general rise in industrial activity, has led to more and more direct (*i.e.* not by-product) manufacture of the acid. Even so, cheapness was maintained because cheap American sulphur was available.

Sulphur supplies

The American salt domes on the Gulf Coast are the world's only source of really cheap sulphur. Unhappily it is now a dwindling source and at the present rate of mining it is considered that in 10 to 15 years the domes will be exhausted. Faced with this situation, the United States, themselves needing vast quantities of acid for their own chemical and fertiliser industries, are now exporting sulphur on a limited allocation basis. They would prefer not to export any sulphur at all and are continuing to do so simply to bridge the time-gap while dependent countries develop other methods of acid production.

To make 1 ton of superphosphate 11 cwt. of fairly strong sulphuric acid are required; no other industrial process requires so much acid. If formerly the economic basis of the superphosphate process was that sulphuric acid was plentiful and cheap, now and in future the situation is inverted. By-product supplies of acid are limited, certainly insufficient now that most modern countries require twice the annual tonnage of superphosphate used before the war. And the ' cheap sulphur ' method of making acid is condemned to the earliest possible death.

The outlook would indeed be grim if sulphuric acid could not be made by other processes. Broadly, any sulphur-containing material can be ' roasted ' to produce the acid. Pyrites is fairly abundant and this can be used; spent oxide from gas works, though limited in supply, can also be used. Calcium sulphate, found in many countries as gypsum and anhydrite, can be converted into the acid. Sulphuric acid can be abundantly or adequately produced by these means *but* costs tend to be higher. Acid from pyrites is somewhat dearer in cost than acid from U.S. sulphur; acid from anhydrite may prove dearer still.

This obviously poses the question, can we convert rock phosphate into an available phosphatic fertiliser without using sulphuric acid or by using much less.

Alternative processes

As we have seen, the main function of the acid is to break up the complex rock phosphate molecule and liberate the fluorine. Any other powerful acid will do this, while high-temperature and electric furnace treatments will do it also. Theoretically, therefore, we are not tied to the time-honoured sulphuric acid at all; in practice, however, we are tied by the fact that any alternative process must yield a fertiliser that is cheaper than superphosphate—or, if it is dearer, one that is a better fertiliser.

Alternative strong acids must obviously be in sufficient supply, and the only one that can pass this test is nitric acid. In theory there is no limit to the amount of nitric acid that any country can produce, since it can be derived from the air by synthetic fixation of nitrogen, but, in fact, of course, plant capacity determines the amount of nitric acid producible, and the question arises—should a country like Britain expand its nitrogen fixation capacity or alternatively expand its sulphuric acid production from such sources as anhydrite or gypsum?

The nitric acid process

We do not lack practical information about the nitric acid process, since in France, Norway and Holland it is already operated commercially, but no one should suppose that nothing more is involved than replacing one acid by the other. With the normal sulphuric acid process, the final superphosphate produced is a solid mixture of soluble calcium phosphate, calcium sulphate, some unchanged rock phosphate and possibly a little free acid. With the nitric acid/rock phosphate interaction, calcium nitrate is formed instead of calcium sulphate. Calcium sulphate is a dry substance and a good ' conditioning ' ingredient, but calcium nitrate is physically objectionable because of its hygroscopic properties. The calcium sulphate formed in making normal superphosphate is accordingly beneficial, but calcium nitrate is objectionable and must be removed or chemically changed into some less troublesome compound.

In Norway and Holland finely ground rock phosphate and an excess of nitric acid are mixed and a solution is formed; by cooling this a point is reached when the calcium nitrate crystallises and can thus be separated. The French process and a laboratory-scale process developed in Britain employ a mixture of nitric and sulphuric acids and enough calcium sulphate is then produced to offset the properties of the calcium nitrate. This compromise may not save as much sulphuric acid, but it enables existing superphosphate plants to be used, whereas a complete change-over to nitric acid requires completely new plant. There is also a British process, so far operated only on a small pilot scale (I.C.I.'s Nitrophosphate process), in which the calcium nitrate is not physically removed but is converted into ammonium nitrate by treating the initial solution with ammonia or with ammonium sulphate.

Nitric acid is much dearer than sulphuric acid, but as it contains 22% of nitrogen, so long as this is made available for fertiliser use the extra cost is recoverable. In the Norwegian and Dutch processes the calcium nitrate is converted into a granular nitrogenous fertiliser, but a recent American comment has suggested that the physical condition of these by-product fertilisers would hardly satisfy American standards.

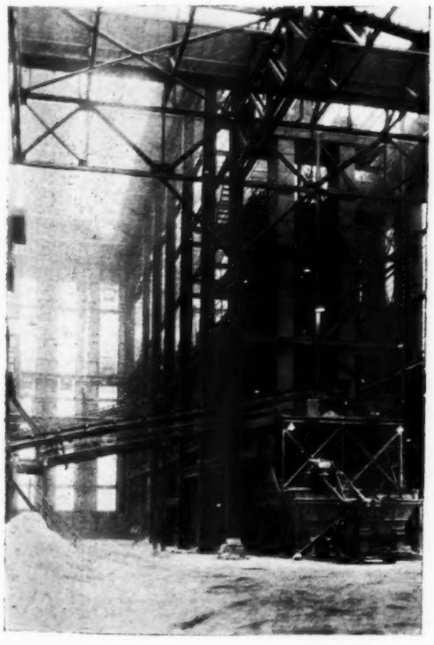
Moreover, it is not easy to see, in the case of phosphate-deficient soils, how far mixtures containing large amounts of nitrogen, which may not in fact be needed by the crop, will be acceptable to farmers. Indeed, it seems obvious that no farmer

Fertiliser bagging unit

will relish paying for the accompanying nitrogen when treating soils for phosphate deficiency. It is indeed difficult to see how any of these nitric acid products can substantially advance into the field so long and simply held by superphosphate. Where farmers adopt the policy of rotating leguminous crops for their nitrogen needs, or under climatic conditions like those in most of Australia where dryness makes fertiliser nitrogen ineffective, there is no hope whatever for the introduction of nitro-phosphatic substitutes for superphosphate.

The addition of suitable proportions of potash converts these NP products into NPK compounds and there the main opportunity would seem to be found. Much of the world's present production of compound fertilisers is based upon

A phosphoric acid plant, showing reaction equipment



Granulating plant preparation unit

superphosphate as the source of P; some of this usage of superphosphate might well be replaced. But even in a country like Britain, where compounds are heavily used, a large demand for superphosphate or some equivalent phosphatic fertiliser would remain.

Perhaps an undue amount of attention has been paid to the nitric acid processes, but so much has been said about them in recent years that it seems important to draw attention to their probable limitations. In the writer's opinion it would be unwise to develop large increases in nitric acid production in order to base phosphatic fertiliser processes upon it. At best the use of mixtures of sulphuric and nitric acids seems preferable, for the product contains less nitrogen and is more akin to ordinary superphosphate.

Thermal treatment

The thermal treatment processes offer the great advantage of yielding final products that are purely phosphatic fertilisers. The raw materials required, other than rock phosphate, are likely to be found in all or in most countries and, if these were the only considerations, there would be no problem in finding a process to replace the sulphuric acid method of treating rock phosphate. The principal difficulty is the high fusion temperature required—for various processes temperatures from 1,100° to 1,600° C. are stated to be necessary. This not only causes a high fuel cost, but, perhaps even more serious, it leads to high running costs, frequent renewals of refractory linings, etc.

Nevertheless, fusion processes have operated successfully and not only in recent years. In Germany, the Rhenania fusion process has operated over a long period, since 1916 in fact. In it, finely ground rock phosphate mixed with silica (as sand) and soda ash form the initial mixture. A similar process was operated in Britain by the Government during the recent war, but unfortunately the cement kilns experimentally used were taken over for their primary purpose when the process had been run for only a short period. So far as the writer is aware, no operating costs have been published, though the product—'Silico-phosphate'—gave an excellent account of itself in field trials, slightly better than superphosphate for some crops, slightly inferior for others and, on the whole, about as effective as superphosphate.

Limiting factors

Recent fundamental British investigations have shown that the availability of phosphorus in the final product depends upon two factors; (1) very quick cooling of the fused mixture; and (2) minimum presence of silica in the initial mixture. The first condition calls for special plant for operation in the fusion part of the process. The second requires that products of this type must always contain a fair amount of silica and, in consequence, fertilisers of greater concentration than 18 to 22% P_2O_5 cannot be expected from the process. The third ingredient of the mixtures for fusion, *i.e.* the soda ash, is not required to break up the rock phosphate complex—silica is an acid and at high temperature does this efficiently. The chief idea is to reduce the temperature at which the reaction proceeds effectively. Indeed, one of the biggest advances that could be made in improving the thermal process would be to find a better 'third ingredient' that will substantially reduce the fusion temperature and yet will not be wanted in amounts which dilute the phosphate content of the product unduly. Potassium-containing minerals have been tried in America and Japan, and there is at least an indication that their use may enable the fusion temperature to be reduced by 100°. Clearly it would be an added advantage if the third ingredient also contained a useful plant-nutrient. Nor should it be forgotten that, if serpentine is used as the mineral source of silica, it provides magnesium, some of which may become

available in the soil. Has enough attention been paid to these thermal possibilities? Coal shortages in many countries since the war undoubtedly cloud their prospects of large-scale development. The fuel demand in the ordinary superphosphate process is, however, negligible, and the real comparison is between the fuel requirement and the sulphuric acid requirement, and any national budget of raw materials will show which shortage is the more serious.

Electrolytic processes

There are other processes for turning phosphate rock into fertilisers of high availability. The element itself can be extracted by electrolytic furnace treatment and subsequently burnt to produce phosphoric acid, which can then be used to treat more rock phosphate, the final fertiliser being known as double or triple superphosphate. This process seems to be economically feasible only in regions where very cheap electric power is available, *e.g.* in the T.V.A. scheme.

Triple superphosphate can also be made by the so-called ' wet process,' but this is no more than an extension of the ordinary superphosphate process and requires sulphuric acid in large quantity. High-temperature treatment in electric furnaces or oil-fired furnaces can also break up rock phosphate and yield fertiliser products, but cheap and plentiful supplies of electricity or oil seem to be the basic requirement conditions for these processes to become practicable.

Atomic energy possibilities

We are told that it will be 20 or 30 years before atomic energy can provide power in quantity and it is unwise to count upon the future of one technology in building hopes for phosphate technology. Nevertheless, there is one unusual aspect of atomic energy development that could considerably improve the economics of phosphatic fertiliser manufacture—some grades of rock phosphate especially. Some of those mined in America contain very small amounts of uranium. It would not be economic to extract this uranium if the rock phosphate was not being mined for fertiliser use, but it can be profitable to extract the uranium during the ' wet process ' for making double or triple superphosphate. It appears also that it is only this process which enables the uranium to be extracted and, if the future development of atomic energy continues to require substantial amounts of uranium, the possibility of turning out by-product uranium from a sulphuric-acid-using process might offset the rising costs of sulphuric acid. Indeed, recent reports from America show that uranium extraction from rock phosphate is being energetically developed or encouraged.

Conclusion

Can any definite conclusions about the future of phosphatic fertilisers yet be drawn? It seems that the nitric acid processes can make only a limited contribution towards saving sulphuric acid ; and the thermal processes appear to be the most promising means of preparing fertilisers comparable with superphosphate, but the operating costs need much more investigation. Most other processes require specially favourable conditions, *e.g.* cheap power. The continued domination of the superphosphate process, based though it must be upon dearer and dearer sulphuric acid, cannot be said to be seriously threatened unless the operative economy of thermal processes can be improved. British plans to produce large tonnages of sulphuric acid from a new anhydrite venture and British efforts to discover new sources of native sulphur should not accordingly be looked upon as ' die-hard ' efforts to bolster up a century-old fertiliser process.

Can we make better use of superphosphate in the soil? This aspect is indeed no less important than questions about alternative processes. The true economic tragedy of available phosphate is not to be found in its cost of manufacture but in the grim facts of soil fixation, for, alas, when superphosphate has been made, transported, paid for and applied to a soil, usually not more than 20 to 25% of its phosphorus gets into the crop, and often the effective proportion is lower still. We have already made useful advances in reducing this wastage; thus, granulation protects superphosphate from rapid fixation, while placement also helps, and there is evidence from America and Russia that organic matter in the soil in contact with available phosphate reduces losses by fixation. We know also that large dressings of superphosphate are more wasteful than small and more frequent ones. It is possible, also, that water-solubility of phosphate should cease to be the criterion by which superphosphate is measured in some countries (including Britain), citrate- or citric-solubility being as effective and perhaps less liable to fixation loss. In New Zealand mixtures of serpentine and superphosphate have been found to be effective, the serpentine apparently enhancing efficiency; this, however, has so far received little confirmation elsewhere. It is clear, however, that there are a number of ways in which superphosphate economy in soils could offset some of the effects of severe rises in its cost per ton.

Last of all, a little should be said about the use of rock phosphate itself. Suitable grades are effective on soils that tend to be wet and acid. The phosphate supply from applications is apt to be slow and steady rather than rapid and early; thus, grassland would be a more suitable recipient than soil being sown to an annual arable crop. All countries facing superphosphate supply problems must inevitably ensure that suitable rock phosphate grades are used to the fullest possible extent in regions where rainfall is relatively high and soils tend to be acid, *e.g.* in the West of England. It is also thought that mixtures of superphosphate and rock phosphate in, say, 4: 1 or 5: 1 ratios, can effectively substitute for the same total weight of superphosphate. The writer questions, however, whether there is sufficient evidence that this is an economy on every type of soil.

Photos : Messrs. Fison's Ltd.—Immingham Factory

Monsanto Licences Soil Conditioner Formulators

To clarify some of the confusion caused in the soil conditioner market of America by exaggerated claims for untested products, Monsanto Chemical Company has announced a programme for licensing formulators under soil conditioner patents. As part of a separate programme for the sale of soil conditioners Monsanto will provide formulators with technical assistance. Formulators will use their own brand names and will be free to list the chemical composition of the product on container labels. The fact that the formulators are licensed under soil conditioner patents issued to Monsanto will also be given on labels.

Until this announcement was made on September 3 by John L. Gillis, vice-president of the Company, Monsanto had sold no soil conditioners to formulators. The Merchandising Division will continue to expand its sales of Krilium soil conditioner.

The first product to be sold to formulators is a modified vinyl acetate maleic acid compound, a product which has proved to be the most effective soil conditioner developed for the home garden, greenhouse, nursery and farm.

The rapidly growing interest in this type of soil conditioner makes the action of Monsanto Chemicals timely.

The Culture of the Tea Bush

A Review of Some Varying Systems

T. EDEN, D.Sc., F.R.I.C.

Director, Tea Research Institute of East Africa

In this paper, Dr. Eden discusses and contrasts certain essential operations in tea cultivation as practised in different countries where the crop is grown. His article is based upon a recent report to the Kenya Government, following a visit to various tea growing countries in the East, by an officer of the Kenya Department of Agriculture.

THE tea plant is grown commercially in widely separated regions, on a variety of soil types and under markedly different climatic conditions. Wherever it is grown its basic requirements are a free-draining soil with a distinctly acid reaction, adequate and well-distributed rainfall maintaining high atmospheric humidity, and tropical or sub-tropical temperatures. Within these definable conditions there is considerable diversity in cultural conditions and techniques, a diversity that is immediately apparent to any visitor, for example touring the tea districts of Assam, Ceylon, Malaya and East Africa.

Varying practices

A study of the varying practices adopted on tea estates in Asia and Africa leads to the conclusion that some of the differences arise from causes inherent in the agricultural and social history of the development of the tea industry in the respective regions. Thus, while it is natural to deplore the somewhat primitive and uncoordinated soil conservation measures practised on many Ceylon tea estates, it is also essential to remember that the terrain is one of exceptional difficulty and that a large part of the acreage was planted on old coffee land in desperate conditions of financial stringency that followed the collapse of that industry after devastation by the Hemileia leaf disease. Moreover, in the last decades of the 19th century there was little or no social awareness of the necessity for soil conservation, there were no machines capable of mechanising terracing operations on precipitous slopes, and there were also two financial depressions between the two world wars. It is true that in Darjeeling in northern India rows of tea up and down the hills were laboriously converted into rough protective terraces, but at that time labour was cheap, and the price premium on Darjeeling teas made available a margin that rendered such work a financially practicable proposition.

Again, it is natural to deplore the absence of refinement in the plucking and pruning of East African tea, but one must remember that the labour force is unstable and drawn for the most part from tribes with no agricultural tradition behind them.

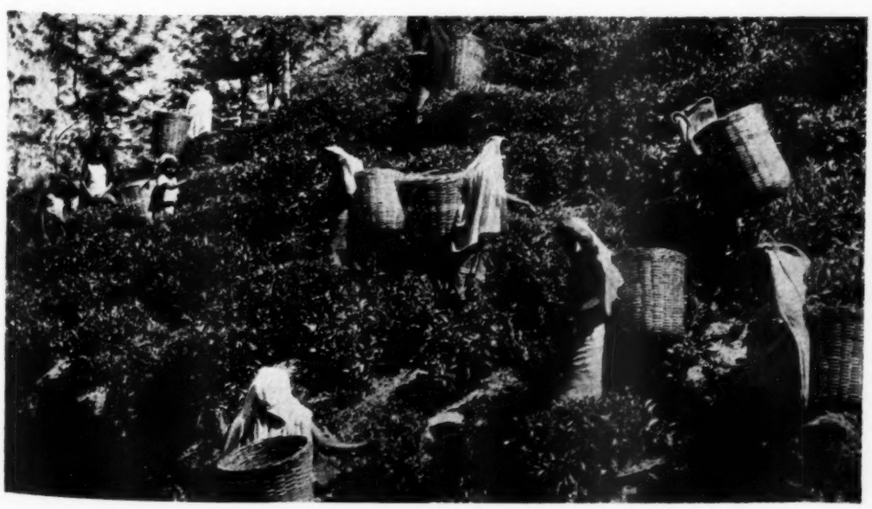
There still remains, however, much diversification of method that is not accountable to historical and social conditions, and it is still a matter for argument whether there is one, and only one, rational method of cultivating and manufacturing tea. Is it possible to hold up the mirror to cultural methods in any region and say ' this is the norm '? Or is it to be expected that each region will perfect a style of its own, suited to its local conditions and world markets, and yet influenced by trends elsewhere and by a much greater degree of consultation between the regional research stations than has hitherto been attained?

A recent publication

These considerations, never absent from the writer's mind during his association with the tea industry, have been impressed afresh upon his attention by the appearance of an interesting and informative publication by Mr. G. Gamble, an officer of the Kenya Department of Agriculture, describing a three-and-a-half-month tour of the tea districts of Assam, Malaya and Ceylon.* The report is divided into three sections, of which the first gives a brief and effective account of the methods employed in Assam, Darjeeling, Malaya and Ceylon. Mr. Gamble has made excellent use of his time and produced a workmanlike account which will have more than an ephemeral value. How few of us by mere reflection can say what was happening before our own eyes 20 years ago? Informative reports of this nature are to be welcomed and are very desirable items of technical literature.

The third part gives a corresponding review of manufacturing procedure, though not specifically regionally conceived. The middle section is devoted to recommendations for the guidance of Kenya planters. In this part Mr. Gamble leans heavily on the recommendations of the Tocklai Experiment Station in Assam. Though he does not say so explicitly, the view that the Assam methods described in Part 1 represent the pure milk of the word, is implicit in most of what he writes.

The writer of this article, on the other hand, looks upon the Assam techniques as very admirable and successful adaptations to the local environment and an outstanding tribute to the cooperation between the Assam industry and its research station.



Perennial bearing tea in Ceylon

* ' Report on Visits to India, Malaya and Ceylon with some notes for the Guidance of Tea Planters in Kenya ' by G. Gamble. Government Printer, Nairobi, 1951.

Fundamentally there is a wide measure of agreement between the systems practised in all the regions where tea is grown, but outside their own boundaries the writer does not consider that any one of the tea-producing countries can claim universality for its particular corpus of opinion or practices.

Contrasting practices: planting

In support of this thesis the remainder of this article will examine in some detail three of the most important diversifications in practice met with in Assam, Ceylon and East Africa, *i.e.* those in planting, pruning and plucking techniques.

Assam practises a planting method which compels the admiration of all who have seen it. Nursery stock planted from seed in the winter dry weather is well developed by the time the next dry weather comes round and is robust enough for transplanting. Mr. Gamble describes the 'bheti' method in his report and equates it with 'ball' planting. As generally understood elsewhere, ball planting involves a consolidation of the earth round the seedling roots which, however desirable in order to preserve the soil round the roots, is accompanied by some deformation of roots and deterioration of soil structure. Bheti planting avoids this because when, by means of the special spade, the slightly tapering prism of earth is cut and the plant lifted, the texture of the soil and its structure maintains the prism intact. With reasonably careful handling this cohesion allows of its transport without damage. This advantageous soil-condition is a natural property of a water-stable stoneless alluvium and is not met with elsewhere in the experience of the writer. Many of the volcanically derived Kenya soils are texturally homogeneous but lack water stability. When dry they crumble; when wet they puddle.

Ceylon tea soils are normally water-stable, but their texture is too coarse for treatment comparable with that given in Assam. For these reasons the tradition in Ceylon is the use of either stumps or basket plants, and in East Africa the use of stumps, because material for basket making is scarce and costly. That the desirability of an approximation to bheti planting is realised is shown by the growing use of transplanters that incorporate a soil-retaining cylinder or box in their design. Nonetheless, the bheti method in its simplicity is not exportable elsewhere.

Pruning

In pruning, the major difference between N.E. India and the other tea countries included in the report is the system of annual pruning practised in Assam and to a lesser degree in Darjeeling. Here a climatic factor is involved. The high latitude of Assam produces a distinct winter season in which the tea plant approaches dormancy. This periodic wintering gives the bush the chance of building up its food reserves and, in the later stages, is an ideal time for pruning. Attempts to advance the pruning period unduly have led to severe incidence of dieback due to carbohydrate deficiency. The combination of high-nutrient reserve status, light pruning and ensuing climatic conditions produce a renewal of maintenance foliage in a remarkably short time and there is no doubt that this system is admirably suited to Assam conditions.

In Ceylon and East Africa, on the other hand, tea is perennially in bearing, no wintering occurs and hot dry periods reduce crop but do not provide physiological conditions analogous to those of a true winter dormancy. Short pruning cycles are successful for a limited period, when crop only is considered, but lead to progressive deterioration of wood.

The results of experiments at the Ceylon Tea Research Institute show that over all but very short periods good frame development and good crops are highly and significantly correlated.

The conclusion is irresistible that the extremely advantageous Assam technique is conditioned by its environment. Mr. Gamble quotes Nyasaland where 'annual pruning has been carried out with considerable success.' Nyasaland has a high latitude, though not so high as Assam, but the continental climate of central Africa has no marked wintering period. Moreover, Mr. Gamble's *obiter dictum* is at variance with the results over a period of years obtained by the Nyasaland Tea Experiment Station (Annual Report, 1950) and with such records on commercial estates as the writer was able to examine during a recent visit.

Fine plucking 'two leaves and a bud'; Ceylon example

Pruning in South India (long pruning cycle)

Indian girls carrying ' bhetis ' ready for field planting in Assam

Plucking

Differences in pruning technique naturally lead to differences in plucking methods. The Assam system, as remarked previously, induces sufficient tipping growth to carry the burden of assimilation and synthesis for crop growth throughout the season. In the course of discussions between the Ceylon and Indian Research Stations some 15 years ago it was suggested that the Ceylon system of post-tipping treatment (*i.e.* to allow three leaves and a bud to develop on a shoot and to harvest only two and a bud for a year or more, thus augmenting the maintenance foliage) involved a needless sacrifice of crop. The proposition was put to experimental test and has provided one of the most spectacular experiments at the Ceylon Institute.

The immediate result was a 50% increase in crop when plucking was at fish-leaf level (without allowing the development of a third leaf). Foliage leaf and wood growth were both drastically reduced and over a period of four years, the total production of dry matter was only two-thirds of that from the normal method of Ceylon plucking. The wood not only deteriorated in quantity but in quality. Consideration of this and other experimental data showed that to maintain a given crop under Ceylon conditions a roughly equivalent amount of maintenance foliage must be produced.

It does not follow that this ratio is universal. It may be that the efficiency of the tea bush under Assam conditions is higher than in Ceylon, and that good crops and good frames can be perpetuated on a crop/foliage ratio higher than in Ceylon. Or it may be that the resting period in Assam so affects the physiological rhythm that the reclothing of the bush and the attainment of the desired equilibrium is quicker than elsewhere. There is at any rate *prima facie* evidence that in this respect wintering tea and non-wintering tea need different treatments. What are now required are data showing the proportions of crop, foliage and wood from pruning cycles of varying length in differing localities in order to give a lead to physiological investigation of these interesting divergencies.

Conclusions

This review has dwelt on points of disagreement with a view to elucidating principles. This must not be allowed to obscure the much larger volume of opinion in Mr. Gamble's report for which there is whole-hearted support. The fact that it is considered profitable to controvert some opinions expressed in the report is a sufficient indication of its general merit.

Photos : The Tea Bureau, London

New Tea Estate

The expansion of tea growing in East and Central Africa is a significant and striking feature of the world tea situation. An indication of this trend is the news that preliminary work on a new tea estate has been started at Inyanga, S. Rhodesia, by an overseas company. Land is being cleared, roads are being built and soil tests are being made. The estate lies between Inyangani Mountain — the highest in Southern Rhodesia—and the border of Portuguese East Africa. The company intends to cultivate at least 1,000 acres of tea and, if its plans are successful, the new estate will probably be the biggest in Southern Rhodesia.

Australian Farmers Encouraged to Grow More Wheat

Australia's Minister for Commerce and Agriculture, Mr. McEwen, has urged Australian wheat-growers to grow the biggest possible wheat crop next year. He made his statement in reply to a question in the House of Representatives.

Mr. McEwen said he had seen reports which pointed out that too large a crop might confront American farmers with problems of storage and later of prices. He added: ' I would say without hesitation that as Australia today is practically the only producer of wheat in the world which sells for sterling and as there is an added desire for sterling wheat because of the shortage of dollars, Australian farmers need have no fear of growing the biggest crop they are capable of growing.'

Cocoa Collecting Expedition

An expedition to the Upper Amazon and Orinoco Rivers for new types of cocoa has been jointly financed by the British West India and British West African Cacao Research Schemes. It is hoped that the British members of the expedition will be accompanied by Colombian scientists and, for the first trip, Dr. R. E. Schultes, who has had long experience of these forests whilst collecting rubber species for the U.S. Department of Agriculture.

The expedition will last some 12 or 15 months and its members will explore five or six localities in the Amazon and Orinoco forests, following the main rivers in aluminium canoes fitted with outboard motors, which can be transported from Bogota, the main base of operations, and from river to river by a Catalina aircraft. The area under investigation is thought to be one of the homes of Criollo, or high-quality cocoa, and it is hoped that results will widen the present range of breeding material. It is also hoped to collect strains or varieties of cocoa resistant to witches' broom disease (*Marasmius perniciosus*), black pod disease (*Phytophthora palmivora*) and to the virus diseases such as Swollen Shoot. If mealy bugs or capsid bugs are found in any quantity they will be surveyed for parasites.

The British advance party consists of F. W. Cope (plant breeder and expedition leader), R. E. D. Baker (plant pathologist) and D. J. Taylor (entomologist), all from the Imperial College of Tropical Agriculture.

A series of reliefs has also been arranged so that no one spends more than three months in the forest without a break.

Protein Production from Green Leaves

N. W. PIRIE, M.A., F.R.S.

Biochemistry Department,
Rothamsted Experimental Station

In this article, Mr. N. W. Pirie discusses the possibility of making use of the protein in green parts of plants to supply increasing food requirements. The possibilities in this direction are intriguing and are attracting growing attention in a number of countries today.

THERE are a few crops that we eat directly as we eat strawberries. There are others that we eat after making a few superficial changes and sometimes after cooking, *e.g.* apples and potatoes. Still others need elaborate processing as in the threshing and milling of wheat. Here what is being done is clearly apparent and even primitive peoples use the techniques. There are, however, crops that need much more expert handling before giving a useful product and these are only useful in communities with considerable technological development. The expression of oil first from olives and then from seeds is an obvious example.

Protein production

No very great skill was needed to get relatively pure oils and carbohydrates from plants, because in many species these are concentrated in seeds and tubers ; but protein is not concentrated in this way and we cannot get a rich protein source by simple operations like peeling and winnowing. The best sources are the seeds of a few legumes which contain 30 to 40% of protein. Under exceptional circumstances leaves also are as rich in protein as this, but more often they contain only 10 to 20% and it is accompanied by so much fibre or highly flavoured material that the leaves can only be used for human consumption on a small scale. But the total amount of protein per acre in the leaves of many crops is very large and the object of this article is to enquire whether our present-day skill in technology and biochemical engineering is adequate for the task of extracting that protein.

Advantages of protein extraction

First we may briefly consider what would be the advantages of protein extraction. Why cannot we be content with the protein that accompanies such predominantly starchy foods as wheat and potatoes and with the proteins of meat and milk which ruminants have derived from leaves? The proteins of seeds and tubers are valuable, but they are not sufficient; the ratio of protein to calories is too low, especially for those who, because of a sedentary occupation, have a small food intake. Furthermore, these proteins have a far-from-ideal amino-acid composition. The animal produces foods that we are accustomed to and like, but it does this wastefully. Thus to produce 100 lb. of protein in the form of beef at least 1,000 lb. of leaf protein are needed. Milk production and egg production are more efficient, but the losses are still heavy. Furthermore, as skill in handling leafy crops increases and as yields are increased by regular use of irrigation and fertilisers, the protein content of the leaf may be raised to such a level that it is wasteful or even harmful to feed the leaf directly to a ruminant. This is not the place to argue this issue fully and it has been argued elsewhere (Pirie, 1942; Synge, 1952).

Isolating leaf protein

Protein is held in the leaf in two main ways: it is dissolved in fluid parts of the cell and it is contained in cell structures such as the nucleus, and more especially, the chloroplasts. When the cells are damaged by grinding or rubbing, the cytoplasmic protein comes out and, in some species, the chloroplasts break up too. In other species the chloroplasts are more robust, but they come out of damaged cells and are small enough to remain suspended in the sap. The problem of making leaf protein is to disintegrate the leaf structure in such a way that the protein dispersed in these various ways can be separated from the other components of the leaf. Rouelle in 1773 did this by grinding leaves in a mortar and pressing the juice out through cloth. In essence this is the method that has been used by most recent workers, whether they are interested in the preparation of leaf protein in bulk or in the isolation of such leaf constituents as enzymes and viruses. It seems to be the method that holds out the most hope for large-scale production, but several alternatives have been proposed. The protein in leaves that have been dried and ground is no longer significantly soluble at neutrality, but much of it will dissolve in dilute alkali and can then be re-precipitated by neutralisation. Although it is much easier to grind leaves when they are dry than when they are fresh, this roundabout procedure seems to offer no real advantage. Another suggestion makes use of the fact that the chloroplasts of many leaves are sufficiently robust to remain more or less intact while the structure of the leaf is digested by enzymes. After digestion, therefore, a protein-rich sludge remains, but most of the cytoplasmic protein is lost because it also is digested. It is easy to recover intact protein or chloroplasts from a leaf extract by heat coagulation, but it would be difficult to recover amino acids or peptides.

Factors involved

In the laboratory it is easy to isolate 80% or more of the protein from the leaves of several species of plants (*cf.* Chibnall, 1939; Crook, 1946; Crook and Holden, 1948). The separation becomes more difficult on a large scale because ground leaves form an intractable dough. Since 1940 I have examined the performance of most of the commercially available types of mill and from this study a few principles seem to emerge clearly. Fine subdivision is not only unnecessary but it greatly complicates the problem of separating the dissolved and suspended protein from the fibre; a rubbing rather than a cutting action is therefore desirable. During rubbing or beating the charge has to be confined in some way, for leaves are not sufficiently brittle to disintegrate on impact if they are unsupported. The cohesiveness of the ground mass effectively rules out the possibility of controlling the period for which the charge remains in the mill in the usual way with a perforated screen; a screen either has no effect or blinds over.

A machine for protein extraction

It is possible that leaves could be satisfactorily ground in some form of stamp or in an edge runner, but most attention has been concentrated on a modified form of the 'Coir Sifter' made by Christy & Norris Ltd. As supplied this was fed tangentially at one end and discharged radially at the other, the material moving through the mill partly on the air stream from a pre-breaker and partly because the mill itself acts as a centrifugal fan. For leaves it works best if the process is more or less reversed so that the mill is fed axially and discharges tangentially. The photo shows the type of machine used. A drum 4 ft. 6 in. long and 3 ft. in diameter

has an axial shaft which carries 58 beater arms. These are arranged as 29 pairs and are evenly distributed so that the unswept spaces in the mill, in which material could accumulate, are not more than 1 in. wide. The original beater arms were plain steel bars 2 in. by 1 in. in section and reaching to within 1.5 in. of the drum. Many variants have been tried, but only the two most successful need be mentioned. In one a ¼-in. plate is set to act as a propellor and is welded to the end of the beater arm so that it reaches to within ½ in. of the drum; in the other two plates are welded to the sides of the arm so as to form a U. All the arms are interchangeable and by arranging a suitable ratio of the propelling and U-type the charge can be moved through the mill at widely different rates. This is obviously important, because some types of leaf need much more thorough grinding than others. The running speed can be varied between 480 and 940 r.p.m., the corresponding speeds at the tips of the beater arms being 71 and 137 ft. per sec.

Similar machines to that described in Mr. Pirie's article for experimental work on protein extraction

Some results

When fed with succulent material such as potato haulm, marrow-stem kale or sugar-beet tops this mill can handle 4 to 6 tons an hour and takes 10 to 20 h.p.; with drier and more fibrous crops such as the grasses the rate of working falls and the power consumption increases. The rate only falls much below one ton per hour when the crop is so dry and mature that protein extraction would be unsatisfactory even in the laboratory. It is not contended that this mill is an ideal solution of the problem, but it works; it cannot become choked as most other mills can and in many hundreds of hours' running it has suffered no damage from the stones and sticks that unavoidably accompany crops handled in bulk. The mill is now being used for routine protein production at the Grassland Research Station near Stratford-on-Avon.

Other methods

Rouelle squeezed out the protein-containing juice through cloth. On a small scale this is an excellent technique, but on a large scale, when the layer of material becomes thick, most of the chloroplasts and chloroplast fragments do not get through the packed mass of leaf fibre. The usual way to overcome this is to have the charge in a press broken up into many layers separated by grids of some sort, but the use of any such arrangement involves much manual work. A flexible belt going through rollers has been tried and worked fairly well, but, as others have found, the belt deteriorates rapidly. Screw expellers, while admirable with oily materials, do not work satisfactorily with materials as harsh and unlubricated as ground leaves. A partial solution to the problem has been found in a rigid perforated steel drum, 4 ft. 6 in. diam. and 2 ft. broad, which is supported on the inside by three steel rollers. Opposite each roller is a spring-loaded 10-in. wooden roller. The milled leaves are fed on to the drum and pass through the three nips before being scraped off; the juice comes through into a tray below the three supporting steel rolls. This machine, which was made by the National Institute for Agricultural Engineering from a design that we thought up together, is still giving valuable service, but it does not get the residue as dry as it should be possible to get it.

Some basic principles

Its shortcomings bring out clearly two principles underlying the successful operation of a continuous press for this type of material; pressure should be maintained for several seconds and there should be no relative movement between the charge and the pressing or filtering surfaces while the pressure is on. With rollers the pressure is applied too briefly; with expellers there is movement in the high-pressure zone. Much more thought and experiment are called for and the problem will probably be solved either by a machine in which the filtering surfaces can slide along a track with the charge, or by one in which pressure is applied by a piston to the charge on a perforated conveyor which is only moved between applications of the pressure. The same problem arises, and has not yet been satisfactorily solved, in various other operations, such as the pressing of water from peat, in which an attempt is made to avoid some of the expense of evaporation.

Range of products

With the present prototype machines 30% of the protein in good-quality leaves from several crops can be extracted in the juice and then separated from it by heat coagulation. The yield can be increased by repetition of the process of grinding and pressing after the addition of water or dilute alkali. The percentage extraction will probably be increased by improvements in mill and press design; this will be valuable, but it is not of vital importance. When treated in this way a leaf gives three valuable products. There is the protein which is suitable for feeding to pigs or chickens directly and, after some refinement, would be suitable for man. There is the pressed fibre residue which contains the unextracted protein and is of relatively constant composition; it is a feeding stuff for ruminants that is more economical to dry than the original leaves, because it has a lower water content and it has a ratio of protein to calorific value that is often more suitable for them. Finally there is the liquor that runs away from the coagulated protein; so far little work has been done on this, but it contains sugars, salts, amino acids, amides, etc., and is a good culture medium for micro-organisms. After processing, all the components of the leaf should be used and it may be more profitable to be content with only partial extraction and full use of the byproducts rather than to incur the extra cost of doing the job more thoroughly.

Suitable leaf types

The leaves that might be used fall conveniently into two categories: those that are at present wasted either wholly or in part and those grown specially for this purpose. There will be little argument about the advantage of using the former; enormous amounts of leaf from crops such as potatoes, sugar beet, sugar cane and sisal are thrown away. Often the leaf is too withered and damaged to be of much use, but with increasing use of irrigation and disease control the proportion that remains lush till harvest is likely to increase. The advantages of growing crops specially for leaf protein production depend, as has been pointed out, partly on the avoidance of the waste inseparable from the use of an animal as a converter. But even if the need is not so great that the protein is used for human food, there

are still advantages. From crops otherwise only suitable for feeding ruminants food for a wider range of animals could be made. A more important merit is that, if the leaf is used directly, full use can be made of the photosynthetic capacities of the plant, and our choice of useful plants is no longer restricted to those that either make a palatable leaf or else translocate large amounts of material into seeds or tubers. The process of translocation wastes both time and material, for only part of what was made in the leaf gets translocated and often during the process the rate of photosynthesis diminishes. We need better plants, selected so that even when cut constantly they remain ready to grow again and photosynthesise vigorously. Grasses have this capacity and it is made use of in the grass-drying industry, but there is the difficulty that the leaves that are most valuable when dried are the most extravagant to dry. It is much cheaper to press out water rather than dry it off. If pressing were coupled to protein preparation there would be very much more incentive to fertilise and irrigate land to the full and make optimum use of the sunlight falling on it. Ideally we need a plant that will go on producing leaf for as long as it is kept warm, illuminated and nourished without any diversion of materials into seed or tuber production. There is no reason why such a plant should not be developed, but until we make better use of leaf there is no adequate incentive to the development.

Potentialities

The proposal is a simple one. In any areas with regular rainfall, swampy areas or areas where irrigation is possible, leafy crops give the biggest return of dry matter per year per acre and if the crop is well fertilised the leaf has a high protein content. Instead of feeding this leaf, whether fresh or dried, to ruminants directly, protein could be extracted from it and used for feeding a range of animals while the residue is fed to ruminants. The idea is not novel, but only recently have the techniques of crop husbandry and biochemical engineering advanced so far as to make it likely that it could be carried out. Much research remains to be done and herein lies the difficulty, for it is by no means clear whose business it is to organise the research. It is not quite food production, it is not quite agriculture and it is unlikely for many years to be a paying proposition. The types of process involved are new and raise new problems; if this were not so they would have been solved long ago. What is needed is an amalgam of logic and crude empiricism; it is important that existing knowledge and skill should be fully used, but it is also necessary to look for new thought and ideas. Many will be silly and many will not be practical, but some will be worth trying and it is only by trying that novel processes will be made to work.

Conclusion

In this article a general theme (*cf.* Pirie, 1951) has been illustrated in terms of a single proposition—the extraction of protein from leaves. But the issue is much wider than that. When we strive to increase production the obvious first step is to do the usual things harder or over a larger area. It is often preferable to develop production along new lines. The total amount of synthesis that goes on in the world is enormously much greater than our foreseeable needs, but it is almost all wasted. Even with that small part that we have under control on cultivated land we only skim off a fraction as the used part of a crop and let the rest slip back by various stages of disintegration into the group of simple compounds from which the next cycle of synthesis starts. In some countries a beginning has been made and good use is made of some hitherto neglected materials such as corncobs and seaweed. But if the requirements of an expanding world population are to be met work will have to be extended to more countries and more materials.

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Photo : Christy & Norris Ltd.

Hungary's Agricultural Plans Announced

An increase of present crop yields by 50 to 60% was needed to supply the agricultural wants of Hungary in view of the big industrial expansion, stated Professor Karoly Kolbai, speaking at the annual meeting of the Hungarian Academy of Sciences, held recently.

The Professor pointed out that in the Soviet Union crop yields were much higher than in Hungary. The yield of autumn wheat was twice as high, and sugar beet three times. Progress was being made in Hungary, however. On State and co-operative farms, for instance, the yield of wheat was 22% higher last year than the average for the 10 pre-war years. The yield of sugar beet was 15% higher and potatoes 47% higher.

To help solve the problems of agriculture, said the Professor, the introduction of grass crop rotation was a primary task. Any delay might increase the deterioration of the soil, and the danger of a fall in productivity. A national afforestation plan for the protection of pasture land should be introduced as soon as possible.

A yield of 40 cwt. of wheat per acre is 'a realistic proposition,'. said Professor Polapov, head of the Budapest University Plant Physiology Institute, when taking part in the debate on Professor Kolbai's paper.

He held that given a suitable soil, correct cultivation, fertiliser and high quality seeds, such a yield could be achieved. A yield of this size should not be beyond the possibility of achievement under Hungarian conditions.

Shell Creates Agricultural Chemicals Division

Shell Chemical Corporation, which recently purchased the Denver firm of Julius Hyman & Co., will centralise all of its agricultural chemical activity in Denver. According to Mr. J. Oostermeyer, Shell Chemical president, Denver will become the marketing headquarters for all of the firm's agricultural products except fertilisers.

The new organisation will be known as the Julius Hyman & Co. Division of Shell Chemical Corporation and will market the insecticides, aldrin and dieldrin manufactured by Julius Hyman & Co., Shell's soil fumigants, D-D and CBP-55 and its long-established line of spray oils which are marketed on the west coast.

Mr. F. W. Hatch has been appointed vice-president of Julius Hyman & Co., and manager of the new division. Mr. Hatch has long been associated with agricultural chemicals and is personally identified with aldrin and dieldrin, which Shell Chemical has marketed since their commercial introduction in 1950.

The location of manufacturing and research departments in Denver will complete the centralisation there of all activities related to the development and marketing of established products such as aldrin and dieldrin as well as of new products still under development.

In addition to the new division office at Denver, area sales offices are being established in New York, Atlanta, Chicago, Houston, St. Louis, Denver, San Francisco, Los Angeles and Portland.

INDUSTRY'S CONTRIBUTION TO AGRICULTURAL RESEARCH—XI

The Toxaphene Story

Work of the Hercules Powder Company, U.S.A.

By introducing chlorinated terpenes as insecticides the Hercules Powder Company opened up a new field. Today, toxaphene has attained wide popularity as an insecticide, especially against the numerous insects which attack the cotton plant.

THE development of the toxaphene insecticides is a good example of industry's contribution to agriculture. Five years ago only the need for a new general-purpose agricultural insecticide existed. Today, toxaphene has been officially approved in the U.S.A. by entomological and farm groups for use against more than 75 destructive insects. The list is growing constantly.

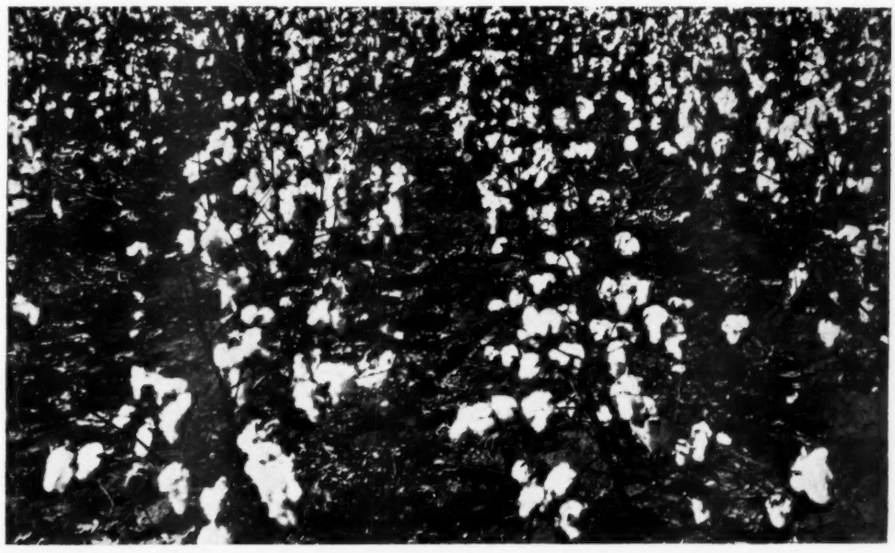
Although toxaphene initially found its widest use against cotton insects in the southern areas of the United States, and in the western states for grasshopper control, its scope has not been limited. Toxaphene has been tested, approved and utilised for control of insect pests on alfalfa and clover, sugar beets, tomatoes, peanuts (groundnuts), wheat, oats, barley, livestock and some fruits and vegetables —to give an indication of the range of toxaphene's usefulness. Tests are now being conducted on a variety of other insects to find new tasks for the material.

Historical

Toxaphene was first produced for commercial use in 1947, but the toxicant on which the insecticides are based is the result of years of research, study and trial. The foundation stones for toxaphene were really laid in 1929 by the Hercules Powder Co., of Wilmington, Delaware, U.S.A. This company, a leading producer of 'naval stores' products derived from pine oil, turpentine and rosin, decided to direct its knowledge of terpene chemicals toward research on insecticides. It was true that pine oil had already been used in disinfectants and insecticides, but the potentialities were not known or imagined. Accordingly, in 1929, Hercules established a fellowship at the University of Georgia for the purpose of exploring seriously the possibilities of naval stores products, both as insecticides and disinfectants. The first use in the insecticide field came when pine oil was used in pyrethrum livestock sprays as an odorant and repellant.

From the various types of terpene-derived alcohols and esters, chemical activators were produced which were useful in other pyrethrum insecticide formulations. Later, a terpene thiocyanoacetate product known as 'Thanite' was developed. This was used as the base for paralytic or contact insecticides for the control of flies and other household insect pests, and as a toxicant and repellant in oil-base livestock sprays. Even in the early days, attempts were made to evaluate chemical structure as it influences the insecticidal properties of terpene compounds, but although some progress has been made recently, precise knowledge on this point is still lacking. There is a possibility that some materials may be excellent for certain specific insecticidal purposes, but only time will prove whether this is true.

'Thanite' is an excellent household insecticide and livestock spray, particularly for control of flies in dairy barns. However, it does not seem to be of great usefulness as an agricultural insecticide.



A fine stand of cotton which has been protected from insect pests. Photo taken in Texas

Chlorination of terpene

Specific attention was then directed to the chlorination of the terpenes. After some preliminary experiments, camphene, a bicyclic terpene hydrocarbon of the formula $C_{10}H_{16}$, was chlorinated to above 60% chlorine content. The result was a unique waxlike product of excellent stability with a high insecticidal activity against houseflies. When tests were extended to include agricultural insect pests, the high activity was shown to be even more pronounced.

Here at last was a most promising new material. The search for a different kind of agricultural insecticide had not indeed culminated, but it had opened up a new avenue of investigation.

The problems

The problems which arose were many. Laboratory tests indicated that, when proper precautions were taken, the material could be used with safety to humans and other warm-blooded animals. Research was also undertaken to determine the degree of chlorination most effective against insect pests. After considerable work, a chlorine content of 67 to 69% was selected and the product was christened temporarily '3956.' These developments were not the work of one man; a team of chemists, entomologists and engineers were by this time engaged on the work.

By now it was clear that Hercules '3956' was ready for more elaborate evaluation and the time had arrived to turn the material over for outside study. Cooperation was sought from universities, state experiment stations and the United States Department of Agriculture's Bureau of Entomology and Plant Quarantine. The value of chlorinated camphene in agricultural insecticides quickly became appreciated, and experiments by outside authorities confirmed the early results obtained by the company. The Bureau of Entomology and Plant Quarantine reported that application in the agricultural field looked quite promising.

With confidence established in the new product, other wheels began to turn. The product '3956' was named 'toxaphene' —'tox' for poison and 'phene' for the camphene from which it was derived. Demands arose for large-scale samples for field trials by other government and state entomological and agricultural agencies, and further toxicological tests were conducted. Production of toxaphene was transferred from the laboratory to the pilot plant, and here additional problems were encountered.

Pilot-plant production

The initial phase of the pilot-plant work proved unsuccessful, and the process had to be returned to the laboratory. Corrections were made and, after this, pilot-plant work proceeded successfully. This resulted in large-scale sample production for extensive field tests.

When the use of toxaphene in agriculture was first contemplated, the company realised that analytical methods were needed to measure the residual toxaphene left on forage crops and in animals consuming these crops. Fellowships were initiated to make these determinations, and a satisfactory method based on the organic chlorine determination was developed.

In 1949, the Hercules Powder Co. relinquished the United States trade mark, toxaphene, and dedicated the name to public use in the U.S.A. The Department of Agriculture's Bureau of Entomology and Plant Quarantine has now accepted toxaphene as the generic term for chlorinated camphene with a chlorine content of 67 to 69% and the name has been endorsed by the American Association of Economic Entomologists, the American Medical Association, the nomenclature committee of the American Chemical Society and the United States Public Health Service.

In less than two years after sending out the samples for testing purposes, the plant at Brunswick began full-scale operations. Today, a plant in England (at Oswaldtwistle, north of Manchester) is now producing toxaphene, and a second plant in the United States (Hattiesburg, Miss.) is in operation.

Results from applications

What results have been obtained through the use of toxaphene insecticides?

For some time the pilot plant continued to turn out the actual tonnage of toxaphene needed for field tests, but meantime plans were made for constructing a full-scale unit at Brunswick, Georgia, where one of the company's naval stores plants is located.

The results obtained with toxaphene in 1947 against many pests were so good that in 1948 numbers of individual states commended it officially for cotton insect control and thus put the stamp of approval on it.

Much of this material produced in the pilot plant was used in experimentation with formulations of toxaphene insecticide dusts, wettable powders, emulsifiable concentrates and oil-soluble concentrates.

At the usual rates of applixation, toxaphene has been found to be nonphytotoxic to a wide variety of agricultural crops, flowers and ornamentals. Cucumbers, squash, melons and other cucurbits are exceptions, however, and can be severely damaged by toxaphene insecticides. Toxaphene has a relatively low chronic toxicity to warm-blooded animals and it is one of the least harmful insecticides to use in the presence of honey bees, although applications should be made in early morning or late evenings hours when bees are not normally visiting blossoms.

Some other advantages of toxaphene insecticides are their good residual effect, a mild, agreeable odour, ease in formulating, compatibility with a wide range of solvents, including those with a petroleum base, and a relatively rapid rate of breakdown in soil, reducing the danger of soil contamination.

Formulations

The most usual formulations of toxaphene insecticides are 10 and 20% toxaphene dusts, 40% wettable powder and emulsifiable concentrates containing 4, 6 or 8 lb. of toxaphene per gal. The 10 and 20% toxaphene dusts are ready for application to crops, whereas the 40% wettable powder and various emulsifiable concentrates must be diluted with water before application as sprays.

Toxaphene has shown promise for the control of garden insect pests and insects attacking ornamental trees and shrubs. Chronic toxicity studies of toxaphene are now in progress to determine official residue tolerances on fresh fruits and vegetables, but have not yet been published.

Fence rows, grown up with weeds and brush, are favourite hiding places for many crop-damaging insects. This farmer applies an insecticide spray as a precautionary measure

Boll weevil, photographed on the 'square' of a cotton plant. The insect punctures the square to lay her eggs and the hatched larvae damage the interior of the boll

Toxaphene for the control of cotton pests

To date, toxaphene's most spectacular success probably has been its use for control of cotton insect pests. It has won

Close-up of a grasshopper feeding on a plant stalk. Hordes of these pests can strip a crop in a matter of hours

wide favour among cotton farmers in the southern United States, because of its effectiveness on a variety of cotton insects rather than just one or two. It has been officially recommended for use as either a spray or dust in virtually every cotton-growing area of the United States, and has been used with marked success in Mexico, Brazil, Peru and other South American and Central American countries.

Animal pests

After careful testing, the United States Department of Agriculture's Bureau of Entomology and Plant Quarantine has recommended toxaphene insecticides for control of certain pests on beef cattle, sheep, wool-producing goats, and pigs.

Manufacturing facilities outside the U.S.A.

Toxaphene is now available for use on crops throughout the world. The chemical is produced for Hercules in England at the Cocker Chemical Co. Ltd. plant in Oswaldtwistle. This unit began operating in October 1950 and is the only unit for the production of toxaphene outside the United States. The Hercules company (which has offices in London and The Hague) has volunteered to assist research organisations and insecticide manufacturers in determining the effectiveness of toxaphene formulations against insect pests which attack crops in all corners of the globe.

Pests controlled by toxaphene

Listed in the next column are the common and Latin names of some of the more important insect pests which have been successfully controlled by toxaphene:

Alfalfa weevil	*Hypera postica* (Gyll.)
Armyworm	*Cirphis unipuncta* (Haw.)
Black cutworm	*Agrotis ypsilon* (Rott.)
Boll weevil	*Anthonomus grandis* (Boh.)
Bollworm	*Heliothis armigera* (Hbn.)
Cattle tick	*Boophilus annulatus* (Say)
Chinch bug	*Blissus leucopterus* (Say)
Clover seed chalcid	*Bruchophagus gibbus* (Boh.)
Cotton aphid	*Aphis gossypii Glov.*
Cotton fleahopper	*Psallus seriatus* (Reut.)
Cotton leafworm	*Alabama argillacea* (Hbn.)
Fall armyworm	*Laphygma frugiperda* (A. & S.)
Garden webworm	*Loxostege similalis* (Guen.)
Granulate cutworm	*Feltia subterranea* (F.)
Green cutworm	*Platysenta sutor*
Gulf coast tick	*Amblyomma maculatum Koch*
Hog louse	*Haematopinus adventicus Neum.*
Lined spittlebug	*Philaenus lineatus* (L.)
Lone Star tick	*Amblyomma americanum* (L.)
Lygus	*Lygus Spp.*
Meadow spittlebug	*Philaenus leucophthalmus* (L.)
Peanut (potato) leafhopper	*Empoasca fabae* (Harr.)
Rapid plant bug	*Adelphocoris rapidus* (Say)
Red goat louse	*Bovicola limbatus Gervais; B. caprae Gurlt.*
Salt-marsh caterpillar	*Estigmene acrea* (Drury)
Sheep tick	*Melophagus ovinus* (L.)
Southern armyworm	*Prodenia eridania* (Cram.)
Southern green stink bug	*Nezara viridula* (L.)
Spittlebug	*Lepyronia quadrangularis*
Sugar-beet webworm	*Loxostege sticticalis* (L.)
Sweetclover weevil	*Sitona cylindricollis Fahr.*
Tarnished plant bug	*Lygus oblineatus* (Say)
Thrips	*Spp.*
Variegated cutworm	*Perodroma margaritosa* (Haw.)
Velvetbean caterpillar	*Anticarsia gemmatilus* (Hbn.)
Western cotton plant bug	*Creontiades femoralis*
White-lined sphinx	*Celerio lineata* (F.)
Winter tick	*Dermacentor albipictus* (Pack.)
Yellow goat louse	*Bovicola penicellata Piaget*
Yellow-striped armyworm	*Prodenia ornithogalli Guen.*

New projects

With the success of toxaphene, Hercules has not abandoned other work on pesticides. At the present time the company has cooperative projects or fellowships in progress at various colleges and institutes in the United States for research on fungicides, insecticides, herbicides and defoliants. The institutions include the University of Cincinnati, Louisiana State University, Clemson College, Oklahoma A. & M., University of New Hampshire, the Battelle Memorial Institute and the Wisconsin Alumni Research Foundation.

At the Battelle Memorial Institute in Columbus, Ohio,* for instance, compounds which show promise as fungicides, herbicides and defoliants are being screened. The Crop Protection Institute at the University of New Hampshire is also the scene of other screening activity in regard to other compounds developed by the company which have demonstrated insecticidal effectiveness.

Through grants of funds or cooperative projects in the past, Hercules has supported studies at the University of Delaware, the University of Maryland, the Montana State College, the Mississippi State College and the U.S.D.A.'s Bureau of Entomology and Plant Quarantine laboratory at Kerrville, Texas. Toxicology studies have also been conducted at Columbia University and the Southwestern Medical College.

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* See WORLD CROPS, **4**, 8, 278-280, August 1952, 'Research in Private Institutes of the U.S.A.'

Training in Pest Control

The City and Guilds of London Institute has recently announced a new scheme for courses and examinations in Subject No. 127, Pest Control (non-agricultural). The scheme has been prepared by an authoritative advisory committee, including representatives nominated by the Ministry of Agriculture and Fisheries, the Industrial Pest Control Association, the Food Manufacturers' Association, the Royal Sanitary Institute, the Sanitary Inspectors' Association, dock and harbour authorities, trades unions, and representatives of technical education and the Ministry of Education.

It is concerned with control of pests of importance in industry and public health, particularly those coming within the provision of the Damage by Pests Act (1949). It does *not* deal with pests of growing crops. The scheme has been devised for operatives, surveyors, and technical staffs of commercial undertakings engaged in pest control, pest officers and sanitary inspectors employed by local authorities, and pest control staffs of industrial, food processing, transport and warehousing organisations.

The examinations will be in two grades, intermediate and final. Particulars can be obtained from the City and Guilds of London Institute, Exams Section, 31 Brechin Place, London, S.W.7.

Rumania's Crops

JOHN CARDEW

In present conditions agricultural developments in the 'Iron Curtain' countries are always of interest and we have already published information in this regard as it comes to hand. The following article provides some particulars regarding the position in Rumania.

A RECENT statement by a Bucharest professor of economics that, given normal trading relations, Rumania could in 1953-55 export between 1,500,000 and 2,000,000 tons of cereals to Germany is a reflection of the progress that has been made in Rumanian agriculture since the end of the war and an indication of the country's interest in expanding its grain exports. Rumania has for long been an important producer of high-quality grain and among European countries still ranks second after the Soviet Union as an exporter.

The pre-war position

Before the war large quantities of Rumanian grain went to Germany under the notoriously unequal trading agreements by which the Nazi Government exploited the food-producing countries of central and south-eastern Europe and, by making them creditors, forced them to support German aggression, receiving nothing in return. In 1939-40, for instance, Germany received over 2,000,000 tons of Rumanian grain for which payment was never made. In spite of the leading place occupied by grain in Rumania's exports at this time, the yields were per unit area actually the lowest in Europe. The wheat acreage yield between 1930 and 1934 was, for example, only a little over 7 cwt. per acre, compared with 23 cwt. in Holland and Denmark and nearly 18 cwt. in the United Kingdom. Exports, in fact, were maintained at a high level at the expense of the living standards of the population. Products of lower nutritive value than wheat were widely used and in most of the country the staple diet was maize, the food of the masses being 'mamaliga,' a maize polenta.

The result was that in spite of this country's great agricultural resources, the Rumanian peasant fared no better than the peasants of other eastern European countries. Agriculture was backward, there was a large army of landless peasants and, up to the outbreak of war in 1939, something like 20% of Rumania's agricultural population was estimated to be surplus.

Post-war development

As in all the neighbouring countries, the first decisive step to end rural poverty and prepare the way for an advanced, mechanised agriculture was the carrying out of land reforms between 1945 and 1948. A total of some 2,589,000 acres of land was distributed among 822,000 families, the maximum holding being 125 acres. Owing to drought, harvests were poor in 1948 and 1949 and it was not until 1950 that the Rumanian people and the Rumanian economy generally began to benefit from this reorientation of Rumanian agriculture.

Rumanian grain is well-liked in export markets

First five-year plan

By the beginning of 1951, agriculture, like industry, in Rumania had sufficiently recovered from the devastation of war and years of sheer neglect to make possible the launching of the country's first long-term plan for the five years 1951-55. Ten per cent. of investments under this plan are to be devoted to agriculture and forestry and the aim is the creation by 1955 of a highly mechanised agriculture which will be predominantly based on collective farms. Collectives are steadily increasing among Rumania's peasantry, who comprise something like 80% of the population, and the high yields achieved during recent years are proving a powerful factor in breaking down age-old prejudice in favour of small-scale individual cultivation.

Under the plan, cultivation of industrial crops, which has been a feature of Rumanian agriculture since the war, is to be considerably developed, the intention being to make the country self-sufficient in cotton, flax and hemp. Eventually cotton is to be grown on an area of 750,000 acres, of which 100,000 will be irrigated. More land is to be brought into production—in 1949 less than 5% of the cultivatable area was under the plough—and a start is to be made with long-term projects for 'transforming nature,' and especially with measures to combat drought in the region between the Danube and the Carpathians. The construction of a network of irrigation canals and afforestation is now going on in this area.

In the course of the five years the area under main crops is to be increased to over 25,000,000 acres. Other means by which it is hoped to raise agricultural production above the 1950 levels by 188 and 219%, respectively, include the more extensive use of fertilisers in the private and state 'sectors', crop rotation and a wider use of selected seeds. Special emphasis is laid on the application of the Russian Dokuchayev-Kostychev-Williams system of crop rotation to Rumanian agriculture and it is expected that the harvests of the principal crops in 1955 will amount to the following:

	Tons
Bread grains	3,740,000
Maize	4,030,000
Pulses	315,000
Sugar beet	2,125,000
Potatoes	2,775,000
Oil seeds	600,000

Other targets for 1955 are: Cotton 230,000 tons, flax 90,000 tons, hemp 325,000 tons, grapes 830,000 tons, fruit 610,000 tons and fodder crops 3,107,000 acres (or 143% of the 1950 area).

Quality of Rumanian grain

Rumanian grain has always enjoyed a high reputation in export markets and it is now claimed that the standard of all

varieties is higher than before the war, due largely—and especially in the case of wheat—to a reduction in the percentage of impurities. The characteristics of Rumanian wheat are its good bread-making properties, its high percentage of nutritive substances and its glassiness. Its average content of protein substances amounts to 14.02%, of starch 60.36% and its glassiness to 52.92%. Its content of foreign substances has decreased compared with pre-war, the average for the period 1944-50 being 3.35%. The main types of winter grain grown at present are A-15, Cenad-117, Bankut-1201 and Odvos-241. A good deal of attention is being paid to improving the quality and the Rumanian Chamber for Foreign Trade recently declared that Rumanian wheat will soon reach the standard of Manitoba and Soviet wheats. A new type of winter wheat developed by Rumanian scientists since the war is Baragan 77; this is to be grown on all steppe lands in the country because of its resistance to drought, cold and grain diseases. It has a hectolitre weight of 80.21 kg., a content of 10.03% gluten and 14.05% protein substances.

Apart from winter grain, Rumanian scientists are now engaged in spreading on a large scale the cultivation of summer grain which, it has been found, can yield record crops in ley-rotations with perennial grass used for the structural rehabilitation of the soil. Summer grain varieties scheduled for large-scale cultivation are Lutescens 62, Albidum 43, ICAR 142-G, Melanopus 69 and Marquis. With the exception of Melanopus, all these varieties belong to the genus *Triticum vulgare*. The hectolitre weight of the summer grain variety is about 78 kg.

Maize

Rumanian maize is noted for its high content of nutrient substances, varying round 87.94 per 100 gm. of dry substances. Of these, starch comprises 71.12%, protein 12.09% and crude fats 5.06%. The main varieties of maize grown are Hanganesc, Cinquantino, Orange Pignoletto, Early Yellow, Ardelenesc de Aries, Scorumnic, Lapusneac and Horsetooth ICAR-54. Horsetooth ICAR-54 is a new variety developed in Rumania and is said to give a good yield of high-quality grain. The name under which Rumanian maize is traded on international markets, ' Dongalfox,' is derived from the areas where it is grown, *e.g.* the Danube basin, Galatz and Foscani.

Rye

Although rye is not cultivated in Rumania on the same scale as wheat and maize, it is a principal crop. The mean hectolitre weight of rye recently exported by Rumania has been 73 kg.; this is slightly higher than the average in the past. The average percentage of glassiness is 22 and that of nitrogenous substances between 9 and 10, although in 1949 it was 10.89. Efforts are being made to improve Rumanian rye and to raise it to the quality of the best European sort, *viz.* that of Poland.

Cotton gathered in the Teleroman region is loaded for transport to a ginnery

Largely as a result of a 12-fold increase in the use of chemical fertilisers, it is anticipated that by the end of the five-year plan cereal production per hectare will reach the following levels in 1955: Wheat, 1,250 to 1,300 kg.; maize, 1,400 to 1,600 kg.; and rice, 3,150 to 3,300 kg. Some of the outstanding yields already achieved suggest that these averages may well be exceeded. For some time there has been widespread application of Soviet agro-technical methods and, as a result of the use of ley-rotations with perennial grasses, crops of 2,200 kg. of summer wheat per hectare have been harvested in regions where summer wheat had never been grown before. The summer-treatment of barley has also resulted in a production of 2,333 kg. per hectare, or 65% more than previous yields, while cross-wise sowing has made possible yields of 2,700 kg. of winter wheat per hectare against normal yields of 1,300 kg. Another Soviet method being increasingly adopted is that of supplementary pollination of maize, which has improved the crop by over 20%.

No opportunity is being lost to demonstrate to peasants that the adoption of improved methods demands a high degree of mechanisation and that, in the words of a recent issue of a Bucharest journal, ' individual farming, on account of the rudimentary means which it adopts, is an obstacle to agricultural progress,' and accordingly the most is made of successes obtained on State and collective farms.

Machinery

Mechanisation of Rumanian agriculture is proceeding rapidly, an important part being played by the country's own production of tractors at the Brasov factory. Formerly an aircraft plant, this factory is now run as a Soviet-Rumanian joint stock company under the name ' Sovromtractor.' It turned out 7,000 tractors in 1949 and 1950, and by 1955 is expected to have an annual output of 5,000 machines, including caterpillar models. By the end of the five-year plan Rumanian agriculture will be served by 28,000 tractors, over 18,000 of them belonging to the 400-odd machine and tractor stations to be established throughout the country. These are also to be supplied with 1,000 combine harvesters; they are already well developed and in 1950 were equipped with more than 6,000 tractors.

Present developments

Last year wheat production in Rumania was 58% above 1950, the output of maize was 29% more than in 1950 and sunflower seeds and sugar beet showed increases of 32% and 126%, respectively. Two factors contributing to the increases were an extension of some 250,000 acres in the area sown to crops and a 60% increase in the use of chemical fertilisers. Large-scale reclamation schemes are constantly bringing more land under the plough and one big project in the Prut Valley in Moldavia, involving the construction of dams over 40 miles long, will when completed make an area of about 120,000 acres

available for cultivation. The building of the Danube-Black Sea canal is helping to turn barren Dobrudja land into fertile soil, and forest shelter belts are being planted in the same region. Since 1949 extensive reclamation work has been going on in the islands where the Danube flows into the Black Sea, which cover an area of 200,000 acres. During the spring of last year, plantings, mainly of cotton and rice, were made on 40,000 acres of land reclaimed here.

After cereals, two of Rumania's most important traditional crops are clover and lucerne, both of which have long figured in the country's export trade. Red clover grows well in Rumania and, because of its high yield and resistance to cold, the famous red clover of Transylvania has always sold readily in world markets. Lucerne also grows well in Transylvania, in the Muntenia plain and in the Banat; Rumanian lucerne seed is in good demand in northern Europe for its resistance to cold which makes it superior to French and Italian seed. Rumanian forage sells in a number of European markets: a year ago, according to a statement by the head of the Rumanian Chamber of Foreign Trade, supplies fell short of foreign demands, and experiments are now under way to find a way of making lucerne hay that will retain its vitamins.

A crawler tractor pulls a reaper and binder on a Rumanian collective farm

Medicinal plants also flourish in many parts of the country and the area devoted to them has increased more than ten times since 1949. At the present time over 50 medicinal and aromatic plants are being cultivated, including mustard, poppy, valerian, mint, camomile and caster. Fruit and vegetables are also grown in large quantities and are permanent exports. Of the numerous experiments being conducted to acclimatise new crops, the most interesting is with tea seed brought from the Soviet Union and planted in the Danube-Black Sea canal zone.

Foliage Spraying Against Manganese Deficiency

IN the extensive field of mineral deficiency conditions of crop plants, foliage spraying performs two valuable services. Firstly, it may be employed to confirm a suspected deficiency and, secondly, it is successfully used in corrective treatment.

Deficiencies of plant nutrients are commonly revealed in the foliage by unusual and sometimes spectacular coloration, chlorosis, necrosis, stunting and distortion. These symptoms have proved very helpful to the expert and to the experienced grower in the visual diagnosis of mineral deficiencies. However, there is often an element of uncertainty in the determination of mineral deficiencies merely by observation of visible symptoms. On some plants the symptoms of manganese deficiency may be confused with those of iron deficiency; waterlogging may give rise to a partial chlorosis of the foliage resembling that caused by deficiency of manganese; the lesions associated with leaf stripe diseases of cereals are not unlike those found in manganese deficiency; and excess of manganese may cause symptoms not easily distinguished from those of deficiency of the same element.

Of the several methods available for confirming a suspected deficiency of manganese, foliage spraying is one of the simplest and most efficient. The spray used is a solution of manganese sulphate and its concentration may vary from 0.1 to 0.3% (1 to 3 lb. per 100 gal. of water). The solution is generally applied early, when the leaves are physiologically active, and the effects can usually be observed from five days to a fortnight after treatment.

Foliage spraying has become increasingly popular in the correction of manganese deficiency and many orchardmen now add 3 lb. of manganese sulphate to each 100 gal. of the usual petal-fall, lime-sulphur spray for apples. Concentrations of varying strengths are used for ground crops; sometimes more than one application is advised.

Wetting agents

It is important, whether for diagnosis or corrective treatment, that a suitable wetting agent or spreader should be added to the spray solution to ensure maximum effect. Ester salts and sulphonated laurol have both proved effective.

The world demand for high-grade manganese sulphate for use in plant and animal nutrition—apart from its employment in industry—is very considerable. There is some evidence that manganese compounds of lower manganese sulphate content and containing varying proportions of insoluble material (*e.g.* oxides) may be adapted to application by spraying with due regard to the type of sprayer used and perhaps some modification of spraying procedure. It is believed that the British producers of manganese sulphate and other manganese compounds propose to investigate this possibility further in the coming season.

DDT Airlift

The Murphy Chemical Co. Ltd., recently received an order for one ton of their DeDeTane 50% DDT Paste and ten spraying machines for Libya, to deal with an infestation of weevil in a large quantity of stored wheat. The problem of controlling this pest was so urgent that it was decided to send the consignment by air freight in spite of the considerable cost involved. In co-operation with B.O.A.C. special arrangement was made to have this airlifted and delivered within a matter of days, thereby preventing a considerable financial loss to the Libyan customer.

The Columbia Basin Irrigation Project

JOHN GRINDROD, B.A. (Com.)

The Columbia River project is the largest and newest of the combined irrigation and power production scheme in the U.S.A., which are the offspring of the New Deal programmes instituted more than a generation ago by the late President Franklin Roosevelt. The inauguration of the Grand Coulee Dam, which forms a central feature of the project, took place in May 1950; it formed the subject of an editorial comment in WORLD CROPS *in July of that year. Since then the project has made considerable progress towards completion which it is expected will be achieved in 1959. Meantime, the following descriptive account of the scope and progress of the scheme will be of interest to our readers.*

BASED on the construction of the Grand Coulee Dam and the harnessing of the Columbia River, the second largest in America, a vast system of irrigation development is now in progress in the Columbia Basin of America.

The programme

Begun in 1948 the present schedule provides for the completion, in 1952, of additional facilities for the irrigation ultimately of a gross area of approximately 87,000 acres, of which about 66,000 acres are to be available for irrigation initially. Future plans provide for bringing into the scheme an additional 55,000 acres yearly and the schedule envisages the irrigation of over 400,000 acres by 1959. Construction is well advanced and is proceeding rapidly. The lands to be irrigated by the waters impounded behind the Grand Coulee Dam lie in the Big Bend of the Columbia River, beginning some 40 miles south of the dam. The project area is approximately 80 miles long, from north to south, and 60 miles wide, from east to west. Althogether it embraces some 1,000,000 acres. Given sufficient water this semi-arid region is considered suitable for the growth of a number of crops, including sugar beet, potatoes, beans, alfalfa, clover, grain sorghums, etc.

The controlling authority

The Columbia Basin Project is a multi-purpose scheme which is being carried out by the U.S. Bureau of Reclamation, an agency of the Department of the Interior, which is entrusted with the reclamation of arid and semi-arid lands of the western United States and the control, development and use of the waters of the 17 Western States, within which region it provides a full or partial supply of irrigation water for more than 5,000,000 acres of land and has installed more than 3,000,000 kW. of electrical generating capacity.

Although the Columbia Basin Project has, as its main purpose, the storage and delivery of water for the reclamation of lands and other beneficial uses, other principal purposes include the generation of electrical power, the control of floods, the improvement of navigation facilities and the regulation of stream flow.

A simplified map of the Columbia Basin Project

The Columbia River

The Columbia River drains an area of 259,000 square miles and its basin includes nearly the whole of Washington, Oregon, Idaho, that part of Montana west of the Rocky Mountains, small areas of Wyoming, Utah and Nevada and 39,700 square miles of mountainous country in the eastern part of British Columbia. About 60% of the water that passes the Grand Coulee Dam comes from river basins in Canada. The irrigation project extends south from the Grand Coulee Dam, which is about 95 miles west of Spokane, Wash., down towards Pasco, Wash. The latter town stands on the Columbia River near the junction of the Snake River, after the former has made its great westerly bend. The areas to be irrigated lie in parts of Grant, Adams, Franklin and Walla Walla counties.

The Grand Coulee Dam

Controlling the whole of the irrigation scheme is the Grand Coulee Dam, the largest concrete structure in the world. By blocking up the river the vast Franklin D. Roosevelt Lake has been formed which extends for 151 miles from the dam to the Canadian boundary. It covers an area of 85,000 acres, averages 4,650 ft. in width and impounds about 9,700,000 acre-ft. of water. No storage of water is needed here for irrigation since the flow of the river exceeds requirements for both power and irrigation in summer.

The water used for irrigation is, in fact, pumped from behind the dam and lifted 280 ft. to a two-mile-long, 16,000 cu. ft./sec. capacity feeder canal for delivery to the Grand Coulee Equalising Reservoir. The pumping plant will ultimately contain 12 65,000 h.p. pumps, each with a designed capacity of 1,350 cu. ft./sec. at a 310 ft. head. It is this equalising reservoir which will ultimately provide the bulk of the water for the irrigation system. At present, as part of the primary system, there is a pumping plant operating on the Columbia River near Pasco. This serves about 5,500 acres but will eventually be dismantled. Three other smaller pumping plants are to

be constructed to serve three separate areas comprising 4,400 acres on the south side of the Snake River near Burbank, and these will remain separate from the primary works.

The distributary system

Twenty-seven miles in length and having a usable storage capacity of 700,000 acre-ft., the Grand Coulee Equalising Reservoir will feed the Columbia River water into the Main Canal, which, after passing through Long Lake, bifurcates into the West and East Low Canals.

The Main Canal has a capacity of 13,200 cu. ft./sec., and consists of unlined and concrete-lined sections, a 1,000-siphon and a two-mile-long tunnel to carry the water to Long Lake. About 5,300 acres of land will be served directly from the Main Canal.

The West Canal has an initial capacity of 5,100 cu. ft./sec. and an ultimate length of 88 miles. It runs round the north-west periphery of the project and en route is carried across the lower end of the Lower Grand Coulee through the world's largest inverted siphon at Soap Lake. It will carry irrigation water for some 288,000 acres in all, but its capacity is reduced progressively by the lateral distribution systems built to serve the entire north-western portion of the project.

With an initial capacity of 4,600 cu. ft./sec. the other canal formed at the bifurcation of the Main Canal is the East Low Canal which runs south toward Pasco. When completed the canal will be 130 miles long and will carry irrigation water for about 259,000 acres.

To collect return flow irrigation water from the upper portions of the areas served by the West and East Low Canals a 30,000 acre Potholes Reservoir has been formed by the construction of the O'Sullivan Dam. From this reservoir, in turn, issue the Potholes West Canal and the Potholes East Canal, both of which help to serve the southern central areas of the scheme.

In addition to this system is planned the East High Canal, the construction of which is, however, at present deferred. This 86-mile-long canal, with a capacity of 3,020 cu. ft./sec., would take water from the Main Canal at Long Lake and would serve the higher lands north of Washtucna Coulee representing about 191,000 acres.

The irrigated area

Of the 1,000,000 acres, which it is contemplated will ultimately be irrigated by the project, about 360,000 acres are sited at elevations higher than the canals. To lift the water up to these areas relift pumping stations will be constructed and will include many small package plants serving only a few hundred acres. Altitudes of the area vary from about 500 ft. at Pasco, at the southern end of the project, to about 1,500 ft. on the northern margin of the scheme.

As a result of power development and irrigation, industries are growing in the Pacific Northwest. Here concrete pipes are being manufactured for nearby irrigation projects

Soils and water requirements

The soils to be supplied are generally light in texture but range from very light loamy sands to loams of medium texture. The various types of land are classified into (a) best, (b) intermediate quality and (c) least desirable for irrigation agriculture.

The quantity of water estimated as being required averages out at 4.0 acre-ft. per acre per year. The actual requirement of each parcel of land, will, of course, depend on the water holding capacity of the soil, and the range here falls roughly between 3.5 to 5.0 acre-ft.

Summer is the season during which the water will be used, beginning in April and lasting through to October. As recorded at 27 meteorological stations over ten years, the frost-free period ranges from about 130 days to 205 days and averages 166 in the year.

Rainfall is variable from year to year but the annual amount averages about 8 in. Most of it occurs in the winter and spring months, winter snowfall usually amounting to 12 to 15 in. In some years the rainfall is less than 2 in.

In January, average temperature over the whole project is 22.4°F., while the July average is 74.4°F. The April-September average maximum is 79°F.

Land allocation

Great care has been taken in formulating the procedure of dividing up the lands to be included in the project and in drawing up the rules governing the settlement of the area. Both of these are provided for under the Columbia Basin Project Act.

In accordance with the provisions of the Act the area will be split up into farm units of varying size ranging, as a rule, between 60 acres and 120 acres, depending on the quality of the land. Nevertheless, a few will be as large as 160 acres and a few smaller than 60 acres. The average size works out at about 71 irrigable acres and each unit is regarded as being sufficiently large to provide a generally accepted, average American farm standard of living.

Division will be based on terrain and soil features and a number of existing parcels of land will be redivided to conform to natural slope and soil in order to eliminate excessive costs and high erosion hazards.

Land values

The Act is also framed to discourage speculation in land values, which, it is felt, would not only be harmful to the security of prospective settlers, but would threaten the investment of the Government. To be eligible to receive water, land must not be sold above its appraised dry-land value. An impartial board will evaluate all land projects on this basis, though re-appraisals, which take into account subsequent improvements, may be called for by the land owner at any time. Revaluation will also take account of fluctuations in the general level of land

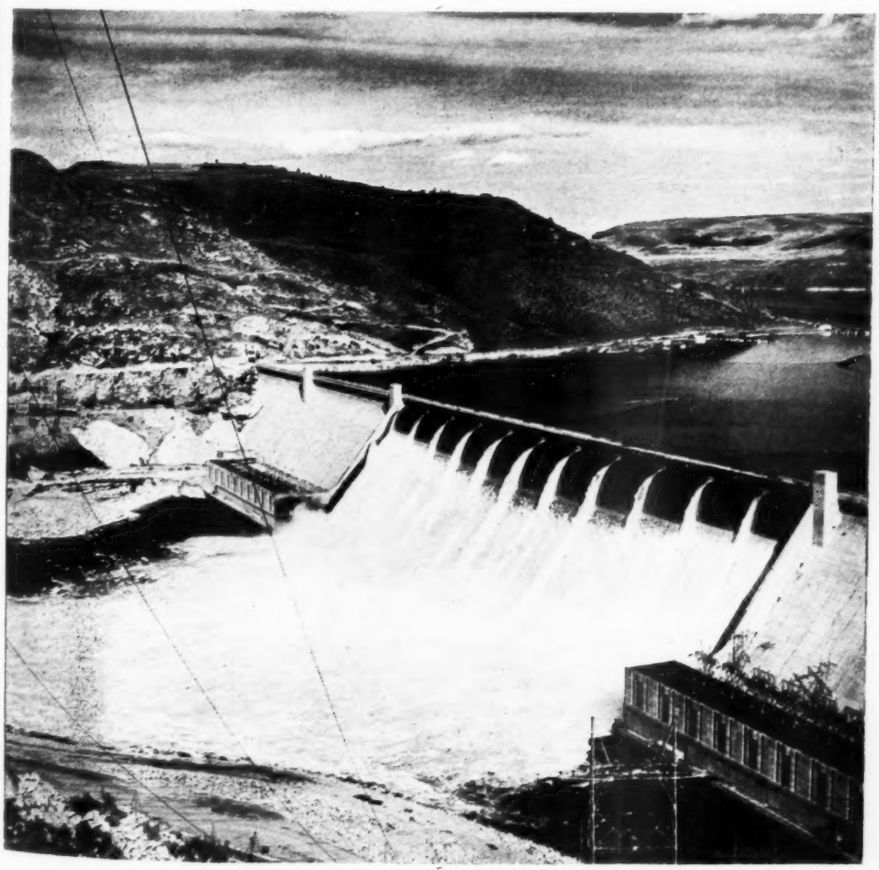
values, the share of construction charges under the project paid by the owner and any other proper items of value. The Project Act further authorises the Secretary of the Interior to acquire and dispose of lands within the area.

A variable scale of charges has been drawn up under which repayment of construction costs and development charges will be made by the water users. These will be paid over a 40-year period; average irrigation construction costs are expected to be in the region of $85 per acre. To facilitate the collection of these charges and other project affairs, three irrigation districts have been organised under state law and these have been split up again into irrigation blocks of from 7,500 to 20,000 acres, each served by one or more complete lateral system.

Steel framework is placed for an irrigation siphon that will deliver water from a reservoir to arid lands of the basin

Reasons for the inception of the scheme

The question is sometimes asked, not only abroad but within the United States itself, why a country like America should set itself to bring more land into production by costly irrigation schemes. This question was answered by Mr. Frank A. Banks, District Manager of the Bureau of Reclamation, in the course of an address to the Washington Public Utility District Commissions' Association in 1945.



View of the Grand Coulee Dam

He pointed out that even in the United States great numbers of people had not been well fed, while millions of acres of land once farmed are no longer fit for farming; erosion and fertility depletion are taking a steady toll of crop capacity and yields-per-acre are declining; with the population increasing at the rate of a million a year, America needs the products of nearly 4,000,000 additional acres of crop land per year to maintain the current standard of living, since it now takes 530,000,000 acres of farm land to support 138,000,000 people.

At the beginning of the present century in America, with a population of 92,000,000, the area of cropped land amounted to 478,452,000 acres while there was an excess of $500,000,000 of agricultural exports over agricultural imports; by 1940, however, the position had been reversed, and with a population of nearly 132,000,000, the area of land under cultivation aggregated 530,131,000 acres while the domestic consumption of agricultural products had increased by a billion (American) dollars annually with only a 10% increase in the land area cultivated. The latter was only achieved because stock on farms had decreased from 27,000,000 to 13,500,000 head, thereby releasing 52,000,000 acres for human needs.

Out of the need for meeting future requirements the Columbia Basin Project was born. When the project is fully developed it will provide opportunities for no fewer than 14,000 farm-owning families,

and the Bureau of Reclamation, who can claim that crop returns from improved lands have equalled about one-fourth of the Government's investment of approximately two billions of dollars in irrigation and multi-purpose projects, will have achieved yet another of its mighty tasks.

Photos : U.S.I.S.

June 1952 Crop Returns for England and Wales

The provisional results of the agricultural census held on June 4 this year show that while there has been a net increase of 216,000 acres in the total area of crops as compared with a year ago, the area of crops which were 'approved' crops for the purposes of the Ploughing Grant, 1952, has increased by 267,000 acres.

The acreage of barley has increased considerably and there has been some increase in oats. Wheat and potatoes, however, show a decline. Beans for stockfeeding and the total areas of feeding roots and other fodder crops show increases. The vegetable acreage has been maintained.

ACREAGE OF CROPS AND GRASS IN ENGLAND AND WALES, JUNE 4, 1952

(Compared with figures for the previous year)

Description	Thousand acres	
	June 1951	June 1952 (Provisional)
Wheat	2,060	1,963
Barley	1,733	2,065
Oats	1,642	1,676
Mixed corn	826	825
Rye for threshing	51	55
Beans and peas for stockfeeding	135	151
Potatoes (first and second earlies and maincrop)	(732)	(679)
Sugar beet	415	400
Fodder beet, mangolds, turnips and swedes	(b) 561	593
Rape (or cole)	133	142
Cabbage, kale, savoys and kohl rabi for stockfeeding	247	250
Vetches or tares	30	27
Mustard, for seeding, for fodder or for ploughing in	59	43
Linseed	27	18
Flax for fibre	23	14
Hops	22	22
Orchards and small fruit	311	309
Vegetables for human consumption (excluding potatoes) crops under glass and flowers—grown primarily for sale	432	433
Fruit and vegetables, not grown primarily for sale	9	11
Other crops	41	29
Bare fallow	377	295
Lucerne	84	106
Total temporary grass	(3,731)	(3,660)
TOTAL ARABLE LAND	13,680	13,765
Total permanent grass	(10,786)	(10,725)
TOTAL CROPS AND GRASS, EXCLUDING ROUGH GRAZINGS	24,466	24,490
Rough grazings (a)	5,443	5,393

(a) Includes common rough grazings.

(b) Fodder beet not collected prior to 1952.

Long Ashton Research Station Open Day

AT the University of Bristol Agricultural and Horticultural Research Station's recent Open Day several items of particular interest were demonstrated. In the Pomology Section, Dr. L. C. Luckwill dealt with fruit-thinning sprays containing alpha-naphthalene acetic acid. These, applied to apples within three or four weeks of petal-fall, induce seed abortion and consequently an increased drop of young fruits. The concentration required to give satisfactory thinning is affected by the variety, the initial set of fruitlets and the stage of development at the time of spraying. The method, therefore, cannot yet be safely recommended in commercial apple growing.

Paper chromatography is being employed at Long Ashton in the study of the auxins controlling fruit development. An exhibit showed some of the tests employed for locating the position of the auxins on the chromatograms.

Plant nutrient investigations

In the plant nutrient investigations under the direction of Dr. E. J. Hewitt, specific visual symptoms on the cauliflower plant were used to demonstrate its molybdenum requirements in the presence of nitrogen applied respectively as nitrate, nitrite, ammonium or urea. Nitrate consistently induced a characteristic mottling, absent from plants given the other treatments.

A survey of the copper, zinc and molybdenum requirements of large-seeded legumes demonstrated that the seed reserves in dwarf, runner and broad beans and in peas could provide sufficient molybdenum for one year's growth, but rarely for two. Seed reserves of these crops also mitigated the effects of copper and zinc deficiencies.

Iron deficiency was induced in sugar beet by excess of copper, zinc or manganese. The degree of chlorosis produced was increased by extra molybdenum and, outstandingly, by copper.

Tracer techniques

The exhibits dealing with insecticides included a demonstration by Mr. S. H. Bennet (working in collaboration with Dr. W. D. E. Thomas) of biological methods, using chrysanthemum plants infested with *Macrosiphoniella sanborni*, for tracing the movement of octamethyl pyrophosphoramide (schradan) through the plant. This method, used in conjunction with radioactive tracer techniques, permitted accurate study of the translocation of the insecticide.

Spraying

Dr. R. J. W. Byrde, of the Mycology Section, demonstrated the effect of winter spray treatments in inhibiting sporulation by *Nectria galligena* (causing apple canker) and *Sclerotinia fructigena*, the brown rot fungus. The effect on *Nectria galligena* was sufficient to reduce subsequent leaf scar infections, but in *S. fructigena* the supply of spore inoculum could be built up sufficiently quickly to outweigh the effect of the winter treatment.

In an exhibit illustrating improvements in spray nozzles, Mr. N. G. Morgan and Dr. H. G. H. Kearns showed two standardised designs. The first was a lightweight, all-purpose, $\frac{1}{4}$-in. B.S.P. nozzle with interchangeable parts for high- or low-volume spraying at low pressures (30 to 75 lb./sq.in.), suitable for light lances, ground-crop booms or air-flow machines. The second was a $\frac{3}{4}$-in. B.S.P. nozzle intended mainly for high-pressure (200 to 400 lb./sq.in.) spraying of fruit trees by means of hand lances or spray masts.

Cider and fruit juices

The exhibits of the Cider and Fruit Juices Section (under the direction of Dr. A. Pollard) were concerned with the practical aspects and with more fundamental work on cider and apple juice production. An exhibit illustrated the yeasts and bacteria giving rise to disorders of cider. The latter included 'sickness' bacteria and lactic rods responsible for the condition known as 'ropiness.' The use of acetic bacteria in the production of cider vinegar was the subject of a practical demonstration.

An exhibit of unfermented apple juices illustrated oxidation phenomena during processing and storage. The addition of small amounts of sulphur dioxide at the time of milling the fruit was shown to inhibit initial rapid oxidation of polyphenolic components, the amount required exhibiting wide variation according to fruit variety. Adequate exclusion of oxygen from the bottled and pasteurised product was shown to inhibit the slower oxidative changes which occur on storage.

The result of field trials with cider apples grown as bush trees was illustrated by Dr. Luckwill and Mr. R. R. Williams. Average annual yields over a period of three years have ranged from less than 1 to over 13 tons per acre, depending chiefly on the variety. These intensive methods have brought their problems of pollination, and work is in progress to determine the self- and cross-fertility of the recommended varieties.

(*From* '*Nature*,' **170**, 263.)

CONFERENCES AND MEETINGS

Sixth International Grasslands Congress

THE sixth International Grassland Congress organised under the auspices of the Food and Agriculture Organisation of the United Nations and the Government of the U.S.A. was duly held in the Pennsylvania State College between August 17 and August 23 last.

Much preliminary publicity had already been given to the Congress, notices of which have appeared in the pages of this Journal. Upwards of 2,000 delegates attended, representing some 50 nations, and during a strenuous week a vast amount of ground appears to have been covered.

The Congress was organised into 12 sections, each under the chairmanship of a recognised authority in this particular field. The subjects covered comprised all the various aspects of grassland improvement, including the improvement and management of pastures, meadows and rangelands, genetics of grasses and forage plants, seed production and distribution, harvesting and conservation of forage, ecology of grasslands, soil management, soil and water conservation, improvement and management of tropical grasslands, the use of forages in feeding, machinery and methods of grasslands research.

The Congress was opened on August 17 by Mr. Charles F. Brannon, Secretary for Agriculture in the United States Government who, after welcoming the delegates and wishing the Congress success, pointed out that there was no iron curtain around technical advances in the United States, and the aim was to achieve advances by pooling knowledge with other people, and learning as a result. Since the first Grasslands Congress was held in 1927 at Leipzig in Germany farming progress had not kept pace with the advances in knowledge and techniques available.

The present Congress provided an opportunity for all nations represented to obtain important facts which could help them to develop a more balanced agriculture, a more profitable livestock industry and a higher level of nutrition for their peoples.

In pointing out that the U.S.A. was at present only getting about 25% of the potential output from its grasslands, Mr. Brannon noted that programmes for grassland improvement were going on in all 48 States of the Union.

In accordance with customary procedure at many conferences of this type, the Congress elected its own president and vice-presidents, these honours going to Dr. Philip V. Cardon, head of the United States delegation, as president, the two vice-presidents being Dr. Claudio Volio, Minister of Agriculture in Costa Rica, and Dr. J. Griffith Davies of the Division of Plant Industry of the Commonwealth of Australia Scientific and Industrial Research Organisation.

It is impossible in the space available to review the work of the sections; as was but natural a large proportion was concerned with work in various parts of the U.S.A., but many also came from other parts of the world and mention may be made of contributions from Sir James Scott Watson, and Messrs. B. Stewart, W. G. Templeman, and O. G. Williams of the U.K. delegation; by Drs. A. J. Virtanen and Axelson Steenburg from the Scandinavian countries; by Messrs. Truble and Walker from Australia; by Professor J. D. Scott from South Africa; by Messrs. B. P. Pal and L. S. Kumar from India; and by Dr. F. T. Wahlen, A. T. Semple and R. O. Whyte from FAO, to name but a few. Among the U.S.A. communications the addresses of the president, Dr. Cardon, on concepts of grassland, and of Dr. Robert Salter on conservation of water and soil, call for mention.

The Congress was made the occasion for many visits, excursions and social functions. Of special interest were the experimental fields of the State College and the Experiment Stations of the U.S. Regional Pasture Research Laboratory.

Numerous exhibits were also arranged in connection with the Congress, including a special one of several hundreds of bulletins and other publications dealing with grassland research, including a stand on which WORLD CROPS appeared.

Technical News

Prof. Melvin Nord writes on 'The Principles of Freeze Drying' in the current issue of *Food Manufacture*. 'Insecticide Specifications Laid Down by the World Health Organisation' and 'Progress Reports on Economic Poisons' are two features of the November issue of *Manufacturing Chemist*. 'The Equipment of Radio-Chemical Laboratories' (including agricultural laboratories) is the subject of an article in *Atomics*. John Hutton writes on 'Coir Fibre' in *Textile Industries and Fibres*. *Muck Shifter and Public Works Digest* features an article on 'The Construction Work for the Water Supply for the New Towns of Stevenage, Hemel Hempstead and Crawley.'

The British Association

THE 114th meeting of the British Association for the Advancement of Science took place in Belfast from September 3 to 10. This year the president of the meeting was Professor A. V. Hill, F.R.S., who chose as the theme of his presidential address the problem which arose from the concluding sentence of the address last year of his predecessor in the presidential chair, H.R.H. The Duke of Edinburgh, *viz.*: How far science has already contributed to human betterment, how far has it provided fresh problems, dangers and difficulties, and how far it is possible to suggest ways in which all concerned with science can help as citizens to make sure that its results are in fact beneficial?

The Agriculture Section

Of the 12 sections into which the Association is divided that devoted to agriculture offers most of interest to readers of WORLD CROPS. In this section the address of the chairman, Dr. N. C. Wright, was concerned with the subject of Britain's food supplies, a topic which has of recent years figured largely in the Association's deliberations, especially since Sir John Russell's memorable address to the 1949 meeting.

Dr. Wright reviewed the course of events in Britain both during and since the recent war. He concluded that owing to the gradual equalisation of the demands for food by different income groups, together with general increases in population, demands for food are likely to increase, while at the same time the lessening availability of world supplies of food combined with the increasing difficulties associated with Britain's balance of payments problem, are likely to limit increasingly the country's ability to purchase food from abroad. The need for expanding domestic food production further is therefore assured and obvious. Whether this will involve a further drastic reorientation of land usage cannot yet be forecast, but even within the present pattern there is ample scope for further improvement by the wider application of science to farming practice.

The Geography Section

The presidential address of Professor R. O. Buchanan to the Geography Section, in which he surveyed some of the historical aspects of the colonisation of overseas territories by Britain, also provided interesting material. He contrasted policies

and events as seen in Australia, New Zealand, Canada and South Africa, and showed that in the earlier stages the efforts of the people on the spot were largely directed to evading the cramping control of regulations imposed by the mother country. In Australia, New Zealand and South Africa this resulted in the establishment of a moving pastoral front which, with the assumption of control by local governments, translated itself into farming fronts with farms of size capable for providing a satisfactory living for a family unit. The settlement of the Canadian prairies on the other hand was largely influenced by American precedents, although it seems doubtful whether the present stage of development really represents the final answer to the occupation of the prairies by a permanent agriculture.

Science and an Expanding Agriculture

At an evening discourse before the whole meeting Sir William Slater, Secretary of the Agricultural Research Council, delivered a noteworthy address in which he reviewed the present task confronting science of keeping pace with the increasing demands for food arising from growing populations, until such time as the spread of education may enable an effective check to be imposed upon the population growth which presses so hard upon the heels of available food supplies.

WORLD CROPS

OUR NEXT ISSUE will include an article by N. W. Simmonds, M.A., A.I.C.T.A., F.L.S., Senior Cytogeneticist to the Banana Research Scheme of the Imperial College of Tropical Agriculture, Trinidad; the title is **Bananas and Manila Hemp.**

The work of **The Swedish Forestry Research Institute** will be the subject of another article, compiled from papers by Prof. Naslund, Director of the Institute.

Industry's Contribution to Agricultural Research, No. 12, will describe the work of Harry Ferguson Ltd. and the **Ferguson Farming System.**

Besides these, other articles, regular features (New Books, Research Developments, Farm Machinery, World Crop Reports, etc.) and the **Annual Index** for 1952 will appear.

American National Agricultural Chemicals Association

THE 19th annual meeting of the American National Agricultural Chemicals Association was held at Spring Lake, New Jersey, from September 3 to 5. Below are brief abstracts from some of the papers delivered at the meeting.

Immunity to insecticides

Speaking on the work of the Bureau of Entomology and Plant Quarantine, Mr. Avery S. Hoyt said that the greatest problem facing entomologists is that of built-up immunity to insecticides, such as has been shown by the housefly in developing resistance to DDT. It has also been found that those strains resistant to one insecticide develop resistance more quickly to substitute insecticides. For instance, there are houseflies in various parts of America which have built up successive resistance to DDT, methoxychlor and lindane, and are also fairly resistant to such powerful insecticides as dieldrin. What would be the effect on people's health in many parts of the world if malaria mosquitoes and typhus-carrying lice become as resistant to the newer insecticides as the housefly is today in many parts of the world ?

The residue problem

Mr. George Decker said that the first assignment in meeting the residue problem was to counteract the unjustifiable adverse publicity of the past two years and to restore public confidence in the applied biological sciences, agriculture and the agricultural chemicals industry. The presence or absence of an objectionable residue of any pesticide was determined by the following factors: time of treatment, stability, rate of residue lost (from materials studied, the order in decreasing rate of loss is lindane, aldrin, parathion, chlordane, dieldrin, toxaphene, DDT and lead arsenate), rate and number of applications, formulation and absorption of chemical.

Technological improvement

' American agriculture is faced with the problem of maintaining continual technological improvement on the farm front.' This was the proposition of Mr. O. V. Wells, Chief of the Bureau of Agricultural Economics, who stressed the increasing importance of agricultural chemicals in this respect. The amount of all pesticides used in the U.S.A. for agricultural purposes doubled from 1944 to 1951, increasing from about 500 million lb. to approximately 1 billion lb. In the five years preceding 1940 farmers were purchasing about 10,000 power sprayers and dusters annually, chiefly of the tree-spraying type. During the last five years U.S. farmers have brought 400,000 power sprayers and dusters, or 60,000 to 100,000 annually, about 80% of which were field or row-crop sprayers. In addition, there are now about 1,900 operators with some 5,500 airplanes available for contract work.

Mr. Wells stressed the importance of increased research work on agricultural chemicals, and attention towards the educational and technical assistance activities of commercial concerns.

Foreign trade

Speaking of pesticide exports from the United States, Mr. P. H. Groggins, of the Chemical Division of the National Production Authority, emphasised the export of pesticide chemicals rather than formulations. Through the Point IV and other programmes foreign agricultural scientists should be trained so that a proper appreciation of pesticides in their own countries might be built up. Mixing plants should be established in customer countries to save transport charges on inert materials and also to preserve precious dollars. Participation of foreign capital should be encouraged in such formulation plants.

Mr. John H. S. Barr, of Pennsalt International Corporation, discussed some of the problems of exporting agricultural chemicals from the U.S.A., mentioning competition from other industrially advanced countries. In this respect, the estimated productive capacities for DDT of some countries during 1952 with the amounts available for export, are given below:

	Metric tons			
Canada ..	500	,,	,,	(350)
France	2,200	,,	,,	(500)
W. Germany ..	1,800	,,	,,	(1,000)
Italy	3,750	,,	,,	(3,000)
Japan	2,700	,,	,,	(1,600)
U.K.	3,000	,,	,,	(1,600)
U.S.A. ..	62,000	,,	,,	(20,000)

' In spite of this,' Mr. Barr said, ' the United Nations has been looking into a programme of installing DDT manufacturing plants in four of the countries where this product has not been made heretofore. In India and Pakistan, for instance, the raw material costs alone amount to more than twice the costs in the U.S.A.

' In the event that DDT is still satisfactory for the health control programme in 1954 (when two of the proposed plants will be put into operation), will it be possible for the country in question to restrict the importation of DDT ? '

Thirteenth International Horticultural Congress

THE International Horticultural Congresses have been a feature for many years past and the thirteenth of the series which was held in London between September 8 and September 16 worthily upheld the tradition established by previous gatherings in regard to the numbers of delegates and the characters of papers set down for discussion.

The last of these meetings to be held in London took place in 1930, and, as on that occasion, the Royal Horticultural Society of England took a leading part in the organisation of this year's meeting. The meetings were held in the Society's halls and divided among several sections dealing with different aspects of horticultural practice, each meeting being presided over by an authority specially chosen for his knowledge of the subjects dealt with.

Lord Aberconway, President of the Royal Horticultural Society, presided over the work of the principal organising committee of the congress.

U.K. progress

The congress was opened on September 6 by Sir Thomas Dugdale, British Minister of Agriculture, who in his opening speech reviewed the progress made in horticulture in the U.K. during the long and troubled years since the last congress was held in 1938. Horticulture, he said, had largely recovered from the effects of the war years and production of orchard fruit was now just above 1939 in volume from a smaller acreage, so that yields per acre had greatly increased. In many parts of the world the last decade had witnessed great advances in the art and science of horticulture. He commented upon the unification of the agricultural and horticultural advisory service in the U.K., which now constituted a new and valuable link between the grower and the scientist, and mentioned the new horticultural stations now in process of establishment and development.

During the course of the congress upwards of 150 contributions were read by various authorities from 27 different countries.

Overseas delegates

Among the delegates from overseas were representatives from most continental countries, including notably two delegates from Russia. Outside Europe delegates were present from the U.S.A., Australia, New Zealand, Canada, Fiji, Hawaii, Malaya, Pakistan and Japan.

Some of the members of the recent Horticultural Congress in London, who visited Fernhust Research Station of Plant Protection Ltd. From left to right, nearest the camera: Dr. R. Maaf of Dielsdorf, Zurich, Mr. A. E. Johnston of Ministry of Agriculture, Stormont, Belfast, Miss A. E. Weber, Lyngby, Denmark (side wearing beret), Mrs. Rothchild, Mr. Rothchild, Dr. Shreeve, Mr. Bywaters and, on extreme right, Mrs. Popenoe of British Honduras

Subjects discussed

Among the subjects discussed, Professor R. H. Stoughton, of Reading University, dealt with the effect of the steady decline of supplies of farmyard manure and referred to the available stores of organic matter which at present are being largely thrown away. He discussed the use of straw sludge composts, and showed that satisfactory composts of definite manurial value could be made from them.

Dr. H. A. Jones, of the U.S.A. Department of Agriculture, described the remarkable progress made in the U.S.A. in producing hybrid onion seed, and the great increases in yield obtained from hybrids. Mr. D. W. P. Greenham, of East Malling, stated that tests had shown the advantages which had resulted from establishing suitable grass and clover swards in orchards in England. Dr. E. J. Hewitt dealt with the importance of molybdenum as a micro-nutrient and described the effect of molybdenum deficiency associated with soil acidity in causing whiptail in cauliflower and broccoli.

Mr. A. F. Posnette, of East Malling, discussed and described the effects of the swollen shoot disease of cocoa in West Africa, while Mr. G. B. Portsmouth, of the Ceylon Tea Research Institute, discussed the problem of blister blight disease in tea in Ceylon.

Dr. A. M. Massee, dealing with insect pests of orchard crops, made a special plea for a detailed study of orchard fauna in all countries which he insisted should lead to considerable modifications in spraying practice and would help the chemist in his search for new selective insecticides.

Dr. H. H. Nicholson, of Cambridge, discussed the effect of the optimum depth of water tables in the soil in vegetable cultivation, while Drs. A. J. Lloyd and C. E. Morgan discussed the efficiency of Krilium as a soil conditioner for horticultural work. Dr. E. Holmes mentioned that at Fernhurst Krilium has been found to be very effective in glasshouses.

Taking all round, the congress can be said to have been outstandingly successful; during and after the congress a series of tours were arranged to enable overseas visitors to see something of English and Scottish agricultural practice.

Growth Regulators

Some interesting remarks on the growth-regulating substances were made at the Third International Congress of Crop Protection (reported overleaf) when Prof. R. L. Wain of Wye College, Kent, discussed the relative activity of a group of well-known growth-regulating substances as shown by their performance in three critical laboratory tests. He pointed out that it was unlikely that phenoxy acids more potent than 2:4-D, 2:4:5-t and MCPA would be discovered, though other types of organic compound might well be found to show high activity.

Prof. Wain mentioned that the most active growth substance of all the 200 he had investigated was the (+)- isomer of α-(2:4:5-trichlorophenoxy) propionic acid.

Third International Congress of Crop Protection

THE Third International Congress of Phytopharmacie was held in Paris at the Sorbonne University from September 15 to 21.

The Congress, the successor of the eminently successful second Congress on the same subject held in London in 1949 under the presidency of Lord Bledisloe, was originally intended to have been held in 1951, but owing to unavoidable circumstances was postponed until this year.

Organisation

The present Congress was held under the presidency of M. Jean Lefevre, Director of the French Institut National Agronomique. Presidents d'Honneur were M. A. Stassens, organiser of the first Congress held at Louvain in 1946, and Lt.-Col. F. J. Griffin, General Secretary of the British Society of Chemical Industry and organiser of the second Congress held in London.

The Congress was divided into eight sections, each of which had a French chairman and secretary; the committee for each section was, however, composed of scientists from foreign countries chosen by the scientific committee of the Congress. The sections included one each on chemical, physical and biological studies, as well as on the modes of action and toxicity of products for the control of insects, cryptogams and other harmful vegetable organisms, on spraying and dusting equipment, on economic problems and on legislation in regard to the use of toxic products.

The Congress opened with an address by the President, M. Lefevre. Among the lectures delivered before the plenary sessions was one on the ' Use of Antibiotics in Crop Protection ' by M. Darpoux, one on ' Growth Substances in Crop Protection ' by Professor Chouard, of the Conservatoire National des Arts et des Sciences, and one by Dr. W. E. Ripper of Pest Control Ltd., on ' Systemic Insecticides.'

The morning meetings (designated ' commissions ') were mainly concerned with standardisation of nomenclature for the testing, manufacture and sale of crop protection chemicals. In the early afternoons addresses to plenary sessions were delivered. Subsequently the numerous sections met to hear and discuss scientific papers. The commissions were by some considered rather disappointing inasmuch as much time was occupied with details such as colours of labels and the legends thereon rather than with the discussion of scientific evidence as the basis for regulations.

No decision was taken regarding the venue for the next Congress, but Stockholm, Milan and Zurich were all mentioned as possible sites.

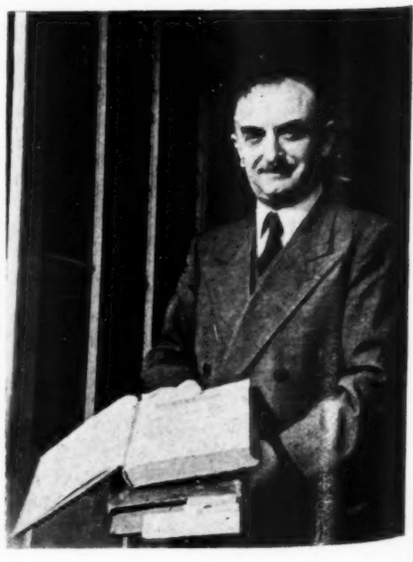
Congress delegates at Versailles ; nearest camera (*centre*) is W. A. L. David of the Agricultural Research Council's Unit of Insect Physiology

Excursions

During and after the meeting several excursions had been arranged, including one to the Centre Nationale de Recherches Agromiques at Versailles. This is the headquarters for agricultural research in France and visitors were impressed by the careful and systematic nature of the work in hand. Although much of the work follows the familiar international pattern, overseas visitors were interested in the work of those problems which are specific to French agriculture. Entomologists were attracted by the very thorough investigations that are in progress on the predators and parasites of some less familiar insect pests.

A delegation of about 45 visited the Vermorel Station, Villefranche, and saw all stages of the manufacture of this Company's famous spraying and dusting machinery.

The Congress must be regarded as a success, but it was generally agreed that the programme was too long and too diverse to be covered adequately in the time available, while it was also considered unfortunate by many that all arrangements for individual visitors to the Congress had to be carried out through one single French tourist agency, no alternative choice being allowed.



(*Above, right*) Prof. Ross of the Ministry of Agriculture, Ottawa (*right*) with Dr. and Mrs. F. Princi, of Cincinnatti. (*Below, right*) Principal of the Horticultural School at Versailles, Prof. Lenfant, displaying the original volume kept by the head gardener to Louis XIV

NEW BOOKS

Efficient Use of Fertilisers

Edited by Vladimir Ignatieff. Pp. 158, illustrated. Published for FAO by Leonard Hill, London. 10s.

The original version of this valuable monograph was first published in 1949 as the ninth of the Agricultural Studies series by the Food and Agriculture Organisation of the United Nations. The original edition having become exhausted, the present version has been issued by the publishers of WORLD CROPS on behalf of FAO. No alterations have been made in the original text although there have been slight alterations in the form of presentation of the work.

At the time of its original appearance we had occasion to comment on the work in very favourable terms in our editorial columns (WORLD CROPS, Vol. 2, p. 47) and there is no reason for us to diverge from the opinions there expressed. It is true that since the original edition was prepared there have been a few developments in the fertiliser position, notably the difficulties created as a result of the sulphur shortage, developments in the placement of fertilisers and the use of radioactive isotopes in tracing the courses of various plant food elements in the processes of plant nutrition, but this does not detract from the value of the information provided, the authoritative character of which is vouched for by the names of the 36 authorities, many of them world famous, who contributed to the book. As we said in 1950, the book contains the essence of world knowledge about fertiliser use, distilled by authorities in many countries and skilfully blended by the editor, Dr. Ignatieff. It is written primarily for agricultural administrators and advisers, but it is to be hoped that it will have a wide circulation among farmers themselves as well as amongst agricultural journalists, politicians and officials.

We think that despite the time that has elapsed since its first publication a debt of gratitude is due to FAO and the publishers of the present edition for making this excellent work available to the reading public.

Green Crop Drying

By. R. O. Whyte and M. L. Yeo. Pp. 328, illustrated. Faber and Faber, London, 1952. 42s.

This is probably the most comprehensive book yet written on the subject of artificially drying young herbage—admittedly a very young ancillary industry. The starting point of the present modern industry may be said to have been about 1926 as a result of Dr. H. E. Woodman's experiments at Cambridge which showed that, '... the dry matter of grass kept young and leafy by systematic cutting (or close grazing) (has) the character of a concentrated food of high digestibility and starch equivalent, rich in protein, carotene and minerals. . . .' Since that time the industry has grown and branched throughout many parts of the world with considerable developments in technique and drier design.

The authors review the present state of knowledge and experience in green crop drying in all countries in which it has been developed, *i.e.* Great Britain, Europe, Scandinavia, North America, South Africa, and Southern Rhodesia. Suitable crops and methods of harvesting are discussed, followed by a detailed exposition of the principles of drying abundantly illustrated with diagrams showing trends in the design of driers. Treatment of the dried product, its nutritive value and manner of feeding are then described. Finally, types of drying enterprises and a chapter on the economics of green crop drying round off a book crammed with facts.

The principal author, Dr. R. O. Whyte, is well known to readers of this Journal and is eminently fitted as the author, having spent some 20 years in the Commonwealth Bureau of Pastures and Field Crops at Aberystwyth, followed by a period with the green crop drying company of Lord Melchett, British Field Products Ltd. Since 1951 Dr. Whyte has been with FAO on surveys of grazing and fodder resources in the Mediterranean area and Uttar Pradesh (United Province), India.

Miss Yeo has had considerable agricultural and horticultural research experience, including work for the Institute of Mycology at Kew and the Ministry of Food.

The only drawback with a book of this type, inevitable though it must be, is that its up-to-dateness may be limited, dealing as it does with a young and rapidly developing industry. As a book on the basic principles of its subject, however, it is not likely to be surpassed and no doubt future editions will be amended to bring the book abreast of the years to come.

Trade in Agricultural Machinery

A Survey of the Trade in Agricultural Machinery. 36th Report of the Commonwealth Economic Committee. Pp. 174. H.M.S.O., 1952. 7s. 6d.

A survey of the Trade in Agricultural Machinery issued by the Commonwealth Economic Committee shows that the value of world exports of agricultural machinery in 1951 was more than £300 million as compared with about £25 million in 1938. While the United States remains the principal producer, user and exporter, expanded production in Commonwealth countries has enabled them to increase their share of the world's total exports from 15% to one-third and to satisfy a rising proportion of their own requirements among themselves. On the whole the rises in agricultural machinery prices since before the war appear to have been considerably less than those of the principal agricultural commodities.

Production of simple implements is carried on in almost all countries, but large-scale output, particularly of the more complex implements and tractors, is confined to relatively few with well developed industrial resources. A particularly notable feature of the production picture has been the post-war emergence of the United Kingdom as the second largest manufacturer of tractors in the world with an output in 1950-51 of well over 20% of the number produced in the United States. Tractor production has also reached considerable proportions in Canada and Australia and arrangements have been made for it to be started in the Union of South Africa and India. Probably the other most significant development was the extension in recent years by the principal manufacturers of their policy of establishing plants in other countries.

An important indication of the spread of mechanisation is the rising number of tractors employed in agriculture: it has been estimated that the world total reached 5.5 million in 1950-51 as compared with 2 million in 1938-39 and 1.2 million in 1930.

The Report draws attention to important changes in the pattern of trade. Immediately after the war the United States and Canada were almost the only exporters of consequence. By 1951, however, the United Kingdom and Canada together provided a third of the world's exports as compared with 15% in 1938, while the United States' share was somewhat reduced.

Balers, loaders and handling gear, electric fencing and dung spreaders have gained rapidly growing popularity. Again,

in Europe root harvesters, in Australia sugar-cane harvesters, and in the United States cotton harvesters give promise of reducing the need for casual labour to gather crops for which the pre-harvest operations have been successfully mechanised. An important aspect of development has been the adaptation of standard implements for new tasks under widely different conditions. Two interesting examples quoted are the application of rotary cultivators and combine harvesters to crops of irrigated rice in India where experiments are reported to have given good results.

Rothamsted Report for 1951

Pp. 212. Obtainable from the Secretary, Rothamsted Experimental Station, Harpenden, Herts., England. 7s. 6d.

This station's report once more follows its traditional pattern and as usual it is admirably done; the total field covered is, of course, enormous and its variety must be beyond the absorptive range of any one reader.

The department of physics continues to show that the rewards from deep ploughing are dubious. Now in their seventh year these experiments are beginning to acquire long-term authenticity. The chemistry department has not unexpectedly given a good deal of priority to testing fertilisers which might be used as alternatives for superphosphate, thus relieving the fertiliser industry's demand upon sulphur and sulphuric acid. Dicalcium phosphate appears to give comparable yields for potatoes and swedes, and the new nitrophosphates behaved promisingly but smallness of granule or particle size seems essential. We can already draw one firm conclusion, that we are not in sight of finding a phosphatic fertiliser that is more efficient than superphosphate. The highest standard attainable seems to be one of equivalence in favourable conditions. There is much to be said, therefore, for another implication, *viz.* that we could remain wedded to superphosphate but save considerably by using smaller dressings on land that has been liberally treated in the past. Savings can also be made if placement is adopted for suitable crops; tests over three years show that band placement of an NPK dressing gave yields of peas and beans superior to those derived from broadcast dressings.

The Botany Department reports studies of feeding plants with major nutrients in foliar sprays. We need to know far more about this method of plant-feeding for there are signs that commercial practice is developing on the basis of exceedingly limited research. It is clear that the spraying method should be embraced with caution. For field crops its efficiency and effectiveness appear to depend on spraying at carefully selected periods of growth. The Plant Pathology Department has shown that yellowing diseases of sugar beet may be due to several viruses, one of which is seed transmitted. The Nematology Department is now able to standardise the substance emitted by potato roots that encourages the hatching of eelworm larvae. The effectiveness of D-D as a soil fumigant for controlling eelworm has been found critically dependent upon the type of soil—thus, though control can be achieved on a black fen soil, the effect on yield is insufficient to repay the cost of application though on a silt soil it gave favourable economic results.

The work on insecticides and fungicides has continued to study particle size, but there is now an indication that this line of approach may have to be suspended while fundamental points in research technique are investigated. Rothamsted's exceptional attention to pyrethrum and now to pyrethrum's synthetic relatives has been continued.

The three survey-papers deal with beet yellows virus and the yellowing virus diseases of sugar beet (M. A. Watson); work on manganese oxidation in higher plants (P. J. G. Mann); and the travelling capacity of insects (C. B. Williams). The last is a superb piece of reportage covering a much too little-known subject; it is rightly provocative and a significant proportion of insect control ' technology ' is challenged by the facts about insect travel, not only the distances insects may cover but the heights at which they fly or drift.

In this space only a small fraction of Rothamsted's total research effort can be referred to. The low price at which this annual report is still issued seems to bear an inverse relationship to its quality.

D.P.H.

To Authors and Readers

The Editor and Publishers of WORLD CROPS will be glad to consider manuscripts of books submitted for publication. We already publish a number of books on technical subjects, all of which find a world sale and most call for regular reprints and new editions.

Books of a non-fictional type in any language by any publisher can be supplied by the Book Department of WORLD CROPS.

PUBLICATIONS RECEIVED

(A selection of Reports, Booklets and Miscellaneous Publications received by the WORLD CROPS *Editorial Office.)*

The Madras Agricultural Journal, March 1952. This is a special conference number embodying the papers that were presented to the Symposium on Manuring of Crops, which was held in July 1951, at the Agricultural College and Research Institute, Coimbatore, S. India. The general conclusion that emerges from the symposium papers is that nitrogen is the prime requisite for nearly all crops grown in Madras. Phosphates require further study and potash is, in general, not considered so essential as the other two nutrients for S. Indian crops, except for coconuts on the west coast.

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Journal of the Association of Official Agricultural Chemists. An American quarterly, this issue (May 1952) contains 78 reports on agricultural products of many descriptions, together with a number of contributed articles and book reviews.

*

'How to Grow Pineapples' and **'Coffee Nurseries,'** are the titles of Extension Circulars Nos. 48 and 49, produced early this year by the Department of Agriculture, Jamaica. The first-mentioned circular comes as a result of the rapidly expanding pineapple canning industry in Jamaica and in 20 pages gives a concise account of pineapple cultivation from start to finish. The second circular has been produced to help the coffee rehabilitation scheme whereby growers are encouraged to select seed from suitable parent trees and germinate the seed in nurseries.

*

Annual Report of the Department of Science and Agriculture, Barbados, 1950-51. A review of the year's achievements, which included the breeding of a new sugar cane variety B.4744. This outyielded the standard variety B.37161 both in tons of cane per acre and in sucrose content, and cuttings of this variety were released for planting on a limited scale last November.

*

Jute and Jute Substitutes in Australia. Report No. T.10 of the Commonwealth Scientific and Industrial Research Organisation. This booklet reviews the possibilities of Australia starting her own jute industry and infers that the large amount of hand labour involved in growing this crop would not make its cultivation an economic possibility, at the present time at any rate.

Report of the Barley Improvement Conference held February 12, 1952, and sponsored by the Midwest Barley Improvement Association of Milwaukee, Wis., and the Malt Research Institute of Madison, Wis. This is the Report of the Annual Conference held to afford an interchange of ideas and information on the subject of barley. It contains reprints of the talks which were given during the proceedings, covering research on barley and malting quality, diseases of barley experienced in Minnesota, fertiliser trials on barley, grain storage research and barley breeding.

*

'Cotton Production Practices in the Black Belt Area and Lower Coastal Plain Area of Alabama.' Two circulars (Nos. 104 and 105) of the Alabama Polytechnic Institute, in cooperation with the U.S. Dept. of Agriculture, Bureau of Agricultural Economics. These booklets describe the cotton production practices and the labour and power requirements in these two areas of the State of Alabama, U.S.A. The Black Belt area is no longer one of the principal cotton-producing sections of the State, although cotton is still a major source of cash income to the farmers. Producers are faced with the problems of (1) the extent to which they should mechanise and (2) the possibility of turning to alternative enterprises having greater natural advantages over cotton production.

The Lower Coastal Plain area is among the principal cotton-producing areas of the State and the problem here is the extent to which growers should substitute machinery for manual labour under existing economic conditions.

*

'The Consolidation of Farms in Six Countries of Western Europe.' This is the fourth issue of the *International Journal of Agrarian Affairs* (Oxford University Press. London: Geoffrey Cumberlege. 5s.) and in this issue contributions from Denmark, Finland, France, The Netherlands, Italy and Sweden are included. They describe the scattered nature of many holdings, how they came to be as they are, and the methods which have been evolved, and which are in use, for rearranging them so that so far as possible they may be in one place.

*

'Indian Tea Association.' Proceedings of the Ninth Annual Conference held at Tocklai last December. Includes the opening address by C. J. Harrison, O.B.E., on the results of ten years' research on the use of sulphate of ammonia under shade. Other addresses were on soil problems and withering experiments.

FARM MACHINERY

This is a Caldwell Giant Brush Cutter, model A-10, shown at work on a Texas ranch. This model, made in Corpus Christi, Texas, can cut brush up to 4 in. in diameter. The cutter's blades have a direct downward thrust, and as the brush is cut into short pieces, the top crust of the soil is loosened without inversion, enabling the land to soak up more moisture and to trap wind-blown seed. The existing turf is not damaged by the cutter's use

Design Trends in Crop Spraying Machinery

New type spring booms, a patent anti-drip device, and flat-topped tanks are some of the new features incorporated in the spraying machines now being manufactured by the Dorman Sprayer Co.

The spring boom has been added to the whole range of trailer machines and has been found particularly effective for use over rough ground such as hurriedly cultivated land and pasture.

The patented anti-drip device is designed to ensure also that the pump does not run dry when anti-drip is in action. Anti-drip is important for the prevention of scorching in such jobs as turf treatment.

Trailer sprayers are now being fitted with flat-topped tanks to facilitate the job of filling the tank with chemical. The curved bottom of the tank has, however, been retained as it assists agitation and prevents particles in suspension settling out into the tank corners.

Brazil to Build Tractors

The Fabrica Nacional de Motores SA (National Motor Factory) of Brazil is to start manufacture of agricultural tractors under a programme approved by President Vargas. The plant will produce some 82% by value of the materials and components required; only the engines will be imported—from the Italian Fiat Company. After the first 1,000 engines have been delivered it is hoped to start production of the engines also in Brazil under licence from Fiat.

Turner Diesel Tractor Prices Reduced

As from September 1, 1952, the price of the Turner diesel tractor has been substantially reduced. For example, the steel wheel model, latterly selling at £818, is now offered at £690.

The decision to revise prices is in accordance with the company's policy, taken in the national interest, of maintaining their position in overseas markets and to offer farmers everywhere the greatest possible tractor value. Price comparisons are given below:

Turner Diesel Tractor	*Old Price* £	*New Price* £
Model on Steel Wheels ..	818	690
,, ,, 11" x 36" Rubbers ..	798	717
,, ,, 14" x 36" ,, ..	870	760

Similar reductions also apply to the range of standard additional equipment for the Turner Diesel Tractor.

Cheaper Garden Tractor

From October 1, prices of the Colwood Garden Tractor, 'Model 'B,' and the Colwood Rotary Hoe, Model 'RA,' have been reduced. The changes, announced by Dashwood Engineering Ltd. are shown below:

Colwood Garden Tractor, Model 'B'
Steel Wheel, reduced to £61 10s. 0d. from £65 10s. 0d.

Pneumatic Wheel, reduced to £62 10s. 0d. from £66 10s. 0d.

Colwood Rotary Hoe, Model 'RA'
Reduced to £75 0s. 0d. from £80 0s. 0d.

Hosier-Curran Grain and Seed Drier

That indefatigable man of ideas, Dr. A. J. Hosier, the Wiltshire farmer-inventor, has recently lent his talents towards the subject of grain and seed drying and designed a drier which is now being manufactured by Edward Curran Engineering Ltd. of Cardiff, under the name of the Hosier-Curran Grain and Seed Drier. It consists of a furnace, fan, ducting, feed hopper with patent feed, drying and cooling tray, with positive agitator and outlet chute. Grain is fed into a hopper which is fitted to the upper end of a sloping drying tray. From the hopper it falls on to the perforated steel sheets forming the base of the tray. The drying tray is 24 ft. long by 7 ft. wide, and the grain travels by gravity to the lower end of the tray while hot air at a predetermined temperature is blown through it from the hot air duct below. The grain is turned as it travels down the tray by an agitating device consisting of moving slats, which also control the flow of the grain.

On reaching the end of the drying tray the grain passes over the cooling section (the last 6 ft. of the tray), where cold air is drawn downwards through the grain. The dried grain finally falls through an unloading chute into hopper or storage bins.

The cold air becomes slightly warm after having been drawn through the dried grain, is then drawn through a duct and into the furnace casing where it is mixed with hot air from the furnace and drawn by a fan for recirculation through the drying tray.

Rate of output is controlled by the feeding mechanism, the angle of the tray, and the agitator; approximately three tons of dried grain can be produced per hour when extracting 5% moisture, using ½ cwt. of coke per hour. Power requirements are 10 h.p. for the fan and 1 h.p. for the agitator.

Although the final price of this new drier has not yet been finally fixed, Messrs. Edward Curran have stated that it will be around £800.

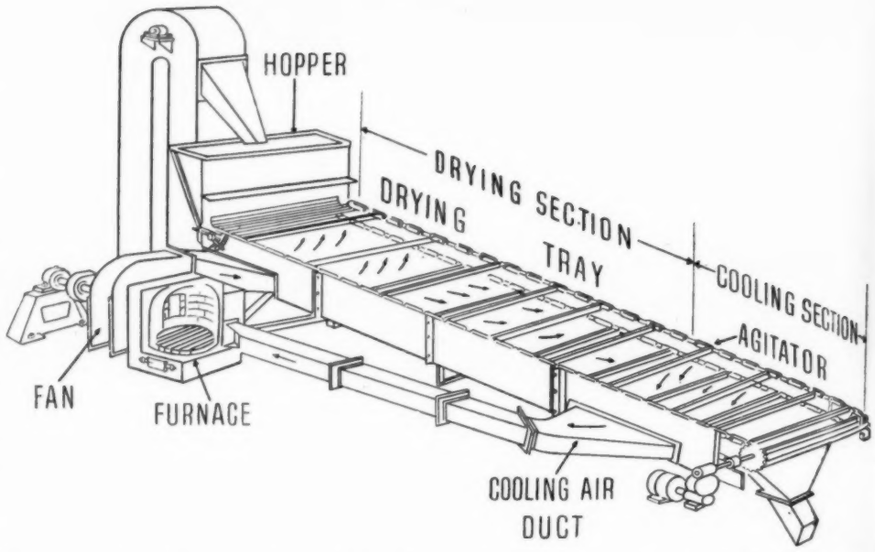


Diagram of the Hosier-Curran Drier showing flow of warm and cool air currents as described on this page

Visiting Yugoslav technicians examining a Howard rotavator at Rotary Hoes' works

Norwegian Fertiliser Factory Planned

Norway's large chemical and metal concern, Norsk Hydro, is to build a factory for production of a so-called complete fertiliser at the rate of 120,000 tons a year. The new plant will be located at Heroya in south Norway and construction is expected to take about two years.

Yugoslavian Technicians Visit Rotary Hoes

Visiting Rotary Hoes recently was a party of Yugoslav technicians who have just completed a month's training at the school of the Ford Motor Co. Following a tour of the works they saw a demonstration of various types of Howard Rotavator, and the accompanying photograph shows Mr. T. Barraclough, Rotary Hoes' export sales manager (second from left), explaining the depth control mechanism of the offset Howard Rotavator for the Ferguson/Ford 8N tractors.

Howard Rotavators featured prominently on the stand of Messrs. Patrick Day & Co. at the recent Zagreb Fair.

Messrs. Rotary Hoes Ltd. have announced that Mr. John Edwards, O.B.E., M.P., has joined them as economic adviser.

Mr. A. C. Howard, managing director of Rotary Hoes Ltd., is at present visiting East Africa, following the recent tour of that area made by Dr. E. McKenzie Taylor, agronomist to Rotary Hoes Ltd. The latter is now in Iraq studying the applications of rotavation to that country's agriculture.

Mr. Howard recently returned from a visit to Brazil, where an associate company has been formed.

Land Reclamation in the Yorkshire Dales

The 4½ acre site before treatment

The same field after initial rotavation

Making the first cut

The field after cutting, showing the 20-ton crop stacked on tripods for drying and the undersown key firmly established

FIRST results are now available of a bold experiment in land reclamation and re-seeding, carried out in the Yorkshire dales earlier this year under the auspices of David Brown Tractors Ltd., who organised a demonstration in conjunction with Rotary Hoes Ltd. and Mr. R. Ratcliffe, of Skipton, on whose land the demonstration was carried out.

Mr. Ratcliffe, who is principal of the Craven Motor Co., is also a practical farmer with pronounced views on the possibilities of mechanisation. It was at his instigation that the experiment was made, with a view to proving that reclamation of rough, barren land of the hill or marginal type is not only practicable but profitable. Needless to say, the venture has been followed with keen interest not only by farmers in the Craven district but by others further afield.

The experimental plot comprised 4½ acres of rough, though fairly flat, pasturage heavily infested with reeds and heather, with high acidity and poor drainage.

The treatment . . .

Commencing on February 21, this field was thoroughly worked, using a David Brown Cropmaster (t.v.o.) and Rotavator. Despite the difficult nature of the land, a good tilth was achieved and, in the course of three separate workings, the headlands were completely rotavated within 1½ in. to 18 in. of the boundary walls. On March 15 this land was dressed, per acre, with 1 ton of ground lime, 6 cwt. of fertiliser (Fison's 6B) and 1 cwt. of Nitrochalk, which was worked in by Rotavator on the following day.

On March 18 2 acres were sown with Scotch recleaned Yielder oats and a week later 1 acre was sown with a special seed mixture for grass silage, and the remaining 1½ acres with a mixture of 15 st. of Scotch recleaned seed oats, 3 st. of large tares and 3 st. of Maple peas. The entire plot was undersown beforehand with a three-year ley for hay and dried grass.

. . . and results

The first cut was made on July 24, with a yield estimated by Mr. Ratcliffe at approximately 10 tons of fodder of excellent quality. Moreover, the undersown ley was well forward and growing vigorously, with every prospect of a good crop when the second cut was to be made later in the year.

Thoroughly pleased with the results so far, Mr. Ratcliffe estimates that he has already recovered his initial outlay, and supplies the following costings to support his claim:

Item	*Cost* £	s.	d.
Lime and fertiliser (4½ acres at £9 6s. per acre)	41	17	0
Scotch seed oats for 2 acres	9	6	0
Seed oats, tares, maple peas for 1½ acres	7	16	0
Silage mixture (1 acre)	5	8	0
Ley (4½ acres)	24	0	0
Contractor's fees (inc. labour, fuel, etc., covering preparation and re-seeding)	34	17	6
	123	4	6
Less Government subsidy of £5 per acre	22	10	0
Net cost	£100	14	6

i.e. £22 7s. 8d. per acre.

As mentioned, this initial outlay has already resulted in a crop of 10 tons of fodder, worth approximately £140 at current prices.

Although eminently satisfied with the outcome of the experiment, Mr. Ratcliffe maintains that equivalent, if not better, results could have been achieved at considerably less cost. For instance, by leaving cultivation until late February, the land was given less time to weather than was desirable. Moreover, the work was undertaken by a contractor, whereas under normal circumstances, Mr. Ratcliffe would have used his own equipment, fitting the work into his normal schedule, with corresponding saving.

On the other hand, he contends that the apparently lavish quantity of fertiliser used was necessary in view of the poor condition of the original soil, and was justified by the quality of the first crop. Similar justification is advanced for the choice of the fairly expensive seed mixture.

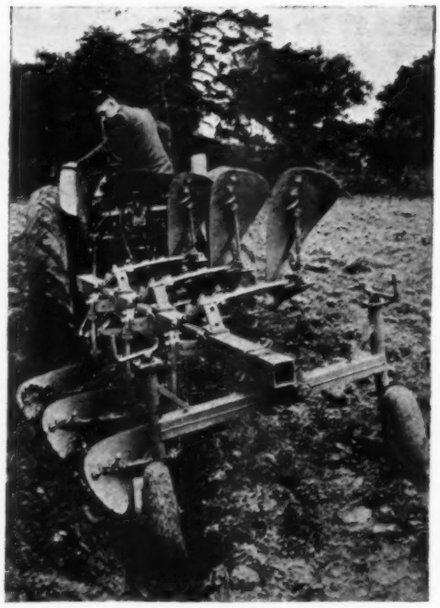
Further work

In addition to the plot referred to above, another six acres of Mr. Ratcliffe's land on the opposite side of the road were reclaimed, using similar methods and equipment, at a public demonstration staged on April 15 and 16. This land, which was even more difficult, being entirely on the slope with gradients of 1 in 5 in places and with numerous gullies and hollows, was rotavated, limed and re-seeded with permanent pasture seed, though the soil, after treatment, was rendered quite suitable for growing any normal crop.

From this plot, too, an excellent crop of hay was taken on July 24, since when Mr. Ratcliffe has pastured 9 cattle and 4 horses on the rich green undergrowth.

Prototype Reversible Plough

The accompanying photograph shows one of the first pictures of the reversible plough, jointly produced by Messrs. Hosier and Bomford, and mentioned by the former in an address to the Institute of British Agricultural Engineers (reported in WORLD CROPS, June 1952 issue). The plough, seen working on Dr. Hosier's farm, is a prototype made on the farm and which is reported as having given satisfactory results after various modifications. The plough works on a patent swinging beam principle operated by two hydraulic rams controlled by the tractor hydraulic system—one to swing the beam over from left to right and *vice versa*. Mounted on the beam are three standard Ransome bodies each side; their distance apart can be regulated. Dr. Hosier considers that there is no reason why the beam could not be extended to carry additional plough bodies, provided the tractor is powerful enough. The castor wheels fitted at the back enable the tractor to reverse if necessary.



One of the first pictures of a prototype reversible plough designed by Messrs. Hosier and Bomford

Trade Publications Received

'The Drying and Storage of Combine Harvested Grain.' One of a series of monographs on malt and malt products which is being published to mark a century's progress of two firms whose activities are in the realms of grain and malt, Multona Ltd. and Edward Fison Ltd. This 35-page booklet describes the combine harvester in the U.K., the properties of grain and air mixtures, cooling and drying grain and grain storage.

'Products with a Pedigree.' An illustrated booklet explaining the rigid examination parts undergo before being put into products manufactured by Caterpillar Tractor Co., Peoria, Illinois.

'Whitlock Mechanisation for the Farming World.' A comprehensive and fully illustrated catalogue of farm trailers and agricultural machinery manufactured by Messrs. Whitlock Brothers Ltd., of Great Yeldham in Essex. More than 50 types of vehicle are made, including those suitable for work under tropical or sub-tropical conditions overseas; one example is a cane trailer with load capacity of 14,000 to 17,000 lb. (560 to 680 arrobas).

Power Farming, a new publication of Caterpillar Tractor Co., with over 100 drawings, presented in the cartoon-form, now being used more and more by Caterpillar for operators' handbooks and other literature, depicts how the modern track-type tractor can relieve the labour shortage in the farming industry and yet provide such conveniences as the farm pond. The book is printed in four languages: English, French, Spanish and Portuguese.

The International Harvester Export Company has recently issued five new catalogues. **Tillage Equipment** is a 24-page booklet describing 18 disc, spring-tooth and peg-tooth harrows. **No. 127-SP Harvester Thresher** described the latest addition to the IH line of combines, including the 127-SP Rice Special, equipment with special tyres or crawler tracks; these machines have variable speed, V-belt propulsion drive, enabling 28 speeds ranging from a slow crawl to 12½ m.p.h. **20-C Field Harvester** gives a 12-page description of this forage and silage crop harvester which will handle up to 25 tons per hour of corn or hay silage. **Best Under the Sun** covers 11 different International power units for irrigation. **Tractores Agricolas** is a new 20-page Spanish catalogue featuring 17 models.

FAO Appointment

It is announced by the Imperial College of Tropical Agriculture that the present principal, Mr. H. J. Page, C.M.G., has resigned as from October 30, to take up an appointment with the Food and Agriculture Organisation of the United Nations.

CORRESPONDENCE

Changing India

TO THE EDITOR

Sir,

The editorial columns of the September 1952 issue of WORLD CROPS contain an item headed 'Superstition and Sterling in India.' These paragraphs contain so many major inaccuracies and misrepresentations that I feel that they should not be allowed to pass unchallenged.

Your correspondent has emphasised the need for restriction of population increase, a need, I can assure you, well appreciated both by the authorities and very many of the inhabitants of this country. Birth control clinics are now a standard feature in most large towns and while, in most cases, it has not been possible to set up similar organisations in the villages, the increased attention being given to raising the general standard of education and the prominence given to the problem of over-population in the press will in time have the necessary effect.

It is, I think, quite untrue to say that family restriction is being obstructed by the religious belief that the father's well-being after death is dependent upon a son being alive to perform the father's funeral rights. The belief may well be there, but it is not the reason for large families. The rapid increase in population is due much more to lack of education, overcrowding, poor living conditions, and an increased conception rate due to low levels of protein nutrition—all economic factors.

It is also quite untrue to say that 'Hindus will not eat flesh or even fish, milk or eggs.' Firstly, your correspondent has, I think, fallen into error by confusing Hindus, who form 80% of the population of divided India, with Brahmins, a caste within the Hindu religion. Secondly, the statement is in any event quite incorrect. Milk is taken universally, and there are very few total vegetarians who will not touch meat, fish or eggs. A great majority of Brahmins in the coastal areas of West Bengal and North and South Kanara districts of South India are fish eaters and the only meat which is universally not consumed by those adhering to the Hindu code is beef. Fish, eggs, poultry, mutton and goat are all eaten, and a recent survey indicates that at least 55% of the population of India are meat eaters and many of the 45% remaining are only vegetarians because of lack of purchasing power. Poverty, rather than religious prejudice, dictates the diet of this country.

It is a matter of some interest that in the State of Madras, long regarded as a stronghold of Hindu ideology, the Fisheries Department has made considerable strides in developing the technique of fish farming in inland areas.

It is true that in certain areas, notably in Uttar Pradesh, monkeys do considerable damage to standing crops, but the attitude towards these animals has undergone considerable change in the last decade and I doubt whether the monkey can now shelter behind the priest. This, however, is a very localised problem and as far as the peacock is concerned, I doubt whether swarms of these, if peacocks can be said to swarm, do anything like the damage that rooks do to crops in the United Kingdom.

At the moment India is experiencing a locust invasion on a hitherto unprecedented scale, some 80,000 square miles being affected. The Locust Control Organisation, under the direction of Dr. H. S. Pruthi, Plant Protection Adviser to the Government of India, is making every effort to combat this menace, aircraft mist-blowers, power-dusters, flame-throwers and the services of the armed forces and police being called into action. This is not the picture of a country where 'plagues of locusts may not be dealt with by reason of the superstition against taking life.'

It must be admitted that one section of the country is, on religious grounds, opposed to the

slaughter of cows, but this prominence given to the sacred nature of cattle in India is rather a matter of party politics and therefore strongly to be deprecated, than a national approach to the agricultural problem, and by no means represents the views of the country as a whole.

Too much ill-informed criticism, often of rather sensational nature, has been levelled against India in the past, criticism that may well harm the efforts of a country struggling to achieve its place in the world. Room for criticism there is no doubt, but it should be criticism of authority too ready to plan but not ready or able enough to execute, of science too prone to theorise but not willing to apply results in the field, of poverty, inertia, petty corruption and lack of education.

The limiting factors in Indian agricultural economy today are lack of enough suitable extension workers to make known to the agriculturists the methods they should adopt, and water. Bound as she is to two monsoons, India's agriculture depends on rain and for five years now the north-east monsoon has failed. Not until the irrigation works now in progress and others projected are all accomplished and the country is to some extent independent of the fickleness of climate will the agricultural economy of India approach stability. But these are matters for 'Point 4,' the Colombo Plan, and the Government of India. For the most part the Indian agriculturist is as able as his counterpart in other lands, and provided that Nature is not too hard on him he can and will produce crops comparable with those obtained elsewhere and unhampered by the superstititions remarked on in your columns.

Yours faithfully,
PETER DE JONG
(Chief Scientific Officer).
United Planters Association
of Southern India.
September 17, 1952.

EDITOR'S NOTE

We showed this letter to the writer of the article on which the Editorial Comment in our September issue was based. In his reply he pointed out that in his original article the superstitions which he cited as obstacles to India feeding herself were not thought to be universal, but only sufficiently alive still to make things more difficult.

In regard to family restriction, in the Editorial Comment we reported our correspondent as saying that the belief in question may obstruct family restriction. He points out that Mr. de Jong admits that the belief may well be there and if so it seems bound to have some effect.

In regard to consumption of flesh by Hindus, our correspondent points out that in his original article he said that 'Many Hindus will not eat flesh of any kind'; in reporting him we unfortunately omitted the word 'many.' He adds that as Mr. de Jong admits that 45% of the population are vegetarian this justifies the use of the adjective.

In regard to damage by monkeys and peacocks his information about the seriousness with which the problem is regarded in India was derived from Mr. Munshi at that time Minister of Agriculture at Delhi, who himself thought it worth while to encourage a campaign for the destruction of monkeys.

In regard to locusts he did not deny that large-scale efforts are being made to control locust infestation but he was told of first-hand evidence of more than one case where peasants had refused to destroy locusts.

Our correspondent concludes by saying 'India cannot afford to have the slightest unnecessary hindrance to the production of food and the limitation of population, and while I never intended and, in fact, never did convey that the superstitions I referred to affected the whole population, there is no doubt that they do influence a sufficient number to make a real difference to India's economic position'.

RESEARCH DEVELOPMENTS

The Anomaly of Systox

In a recent article by Goodman[1] on the new systemic insecticide, Systox, attention is drawn to the very low water-solubility of this substance. In the same article, and in other statements,[2] it is implied also that systemic insecticides must be water-soluble, because the moving aqueous sap of the plant provides the only obvious means of translocation.

The systemic behaviour of a compound said to be soluble to the extent of only one part in 15,000 of water constitutes an anomaly which is a challenge to simple physico-chemical theory.

This challenge has been taken up by the research team at the Harston laboratories of Pest Control Ltd., who have already published information on the chemical reactions of Schradan and related compounds in living plants obtained by the radio tracer technique.[3, 4] The first results of their investigation of Systox were briefly announced at the recent International Conference on Phytopharmacy in Paris. Not only has the anomaly been explained, but the explanation has revealed facts of serious significance for the safety of this insecticide to the consumer.

Systox contains two active ingredients. In addition to the O,O diethyl O_2 (ethyl-mercapto) ethyl thiophosphate (S-P-O-C compound) which alone is nominated in most descriptions,[2, 5, 6] there is present in comparable amount the isomeric O,O diethyl S_2 (ethyl mercapto) ethyl thiophosphate (O-P-S-C compound). The formation of the second from the first occurs more easily than the similar isomerisation in parathion, and there is no evidence of exchange of the S atom with the O atom in the unsubstituted ethoxy groups.

The O-P-S-C compound shows much more polar behaviour in solution than the S-P-O-C isomer and is about 0.2% soluble in water. Advantage is taken of this higher solubility in polar solvents to achieve chromatographic separation. The O-P-S-C compound is much the more toxic both to insects and mammals and is the really active ingredient. Without it the preparation would have very mediocre insecticidal properties.

The greater water solubility of the more active ingredient does not, however, turn out to be by any means the complete explanation of the anomaly referred to above.

Even the O-P-S-C compound is extracted completely from water by shaking with an equal volume of iso-octane. The O-P-S-C compound, labelled with ^{32}P, was applied to the roots only of brassica seedlings and, after a few days, aphids were dying on the leaves. The leaves were macerated in water and the macerate extracted with iso-octane. Hardly any radioactivity passed into the iso-octane. Chloroform, however, extracted the bulk of the activity. After evaporation of the chloroform layer in the presence of water, re-extraction of the water with iso-octane confirmed the first result, showing that the greatly increased water solubility was real and not due to association with dissolved sap-substances.

The conclusion is inescapable that the O-P-S-C compound is very rapidly converted into a more water-soluble compound within the living plant and that it is a derivative which is translocated and is responsible for the systemic insecticidal action on the aphids.

Even this, however, is not the end of the story. Analysis of successive extractions showed that the substance extractable by chloroform but not by iso-octane is not one compound but two. Brassica seedlings, turnips, sugar beet and nettles all produced a similar conversion. The derivatives were separated and concentrated. Injected into mice these derivatives showed toxicity much greater than that of the S-P-O-C compound, and close to that of their progenitor.

Yet a third compound, more water favourable still and not extractable by chloroform, was extracted very inefficiently by butanol and shown to possess anti-cholinesterase activity.

The S-P-O-C isomer was also shown to undergo similar conversion in the plant, but the toxicity of the derivatives has not been investigated.

The original compounds are converted rapidly and completely into the derivatives, which persist for several weeks. This may explain why it has been reported that toxic residues disappear very rapidly in the case of Systox treatment, despite its persistence as an insecticide. The case of Schradan is entirely different, since no toxic derivative in significant amount[1, 7] persists in the plant.

G. S. HARTLEY

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WORLD CROP REPORTS

NIGERIA

Cocoa Marketing Board's report. The fourth annual report of the Nigeria Cocoa Marketing Board, recently published, records that the 1950-51 cocoa crop, amounting to over 110,000 tons, was the heaviest for a number of years, and it is regarded as an encouraging sign that the effects of the swollen shoot disease have not so far seriously impaired the potential of the cocoa-growing areas. It is realised, however, that a continued high level of production demands a planned and sustained effort, and the future prosperity of Nigeria's cocoa industry will depend largely on the success of the agricultural rehabilitation and replanting schemes undertaken by the Board.

The large crop in 1950-51 coincided with a period of very high world market prices for cocoa, and the surplus accruing on the Board's operations during the year was £11,200,000. The Board was thus able to allocate some £7 million to the Eastern and Western Regional Production Development Boards and to finish the year with price stabilisation reserves amounting to over £27 million.

The Board has also taken measures, which proved successful, to raise the quality of Nigerian cocoa, and has encouraged the development of cooperative movements among the producers.

PHILIPPINES

Sugar survey report. Crop survey reports submitted to the Sugar Quota Administration indicate that the coming 1952-53 crop may reach at least 1,325,000 short (1,183,000 long) tons, states a Manila report. Of this, 300,000 tons will be set aside for local consumption requirements, whilst 952,000 tons (tel quel) would be required for the United States under the Sugar Act. This then would leave an apparent surplus of 73,000 short tons to fill any additional outlet in the U.S.A. which may eventuate, or for export to the free market.—*From Czarnikow's 'Sugar.'*

AUSTRIA

Harvest prospects. Medium crops of winter grains are reported from most areas of Austria. Oats and summer barley have given good yields, while root crops are promising despite the summer drought and insect pests.

Fruit crops are expected to be generally poorer than last year and the wine harvest promises to be of good to very good quality. The wine yield will be of average volume.

ASIA

Tea production. Comparative figures of tea production for the last two years in Pakistan, Indonesia, Ceylon, South India and North India, as given by the International Tea Committee, are shown in the table below:

(Quantity in thousand lb.)

Country	*Period from April 1*	1950-51	1951-52
	Months		
Pakistan ..	12	52,373	53,791
Indonesia ..	12	80,643	100,405
Ceylon ..	12	308,546	329,252
South India	12	98,681	119,517
		1951-52	1952-53
North India	2	42,200	64,600

U.S.A.

Record rice forecast. According to the U.S. Department of Agriculture, a production of 45.4 million cwt. of rice is expected from the harvest of the 1952 crop in the United States. If this is so the crop will be 4% greater than in 1951, which itself was a record, and 38% higher than the average for the last ten years. The 1952 rice acreage is about the same as in 1951 and a high average yield of 2,319 lb. per acre is expected.

DENMARK

Promising grain harvest. According to reports from a number of experts all over the country, the grain harvest promises to be unusually large. Estimates for wheat and spring corn on August 1 ranged 4 to 6%, and for rye 12%, higher than at the same time last year, which must be considered a good crop year.

Also, in the case of most root crops, the prospects are substantially better than last year.

TURKEY

Good grain yields. Turkey's grain harvest has turned out even better than anticipated and the figure of 1.5 million tons of grain available for export is expected to be surpassed. In the Konya area alone, where some 75% of the harvest is already under cover, the crop is put at 1.3 million tons, or 400,000 tons more than in 1951.

Apart from the deal with Yugoslavia for the export of 100,000 tons of Turkish wheat, little foreign business is reported. Turkish exporters consider the price of 77 dollars for barley and 76 for maize, fixed by the Ministry of Agriculture, to be too high to encourage transactions.

JAMAICA

1952 sugar harvest. The 1952 harvest has now been completed and the final output is preliminarily given as 265,872 tons, which compares with 267,928 tons produced in the previous season.

The 1953 crop estimate of 285,500 tons remains unchanged.—*From 'Sugar.'*

GREECE

The area planted to cotton in Greece for the 1952-53 crop has been estimated at about 215,000 acres, compared with the 212,000 acres harvested in 1951-52. Weather conditions at the time of planting in April and May were not favourable for germination of the seed due to continued drought from the early spring and unusually hot, dry winds during the latter part of April. Some insect damage has been reported in the dry land areas, and use of insecticides and fertilisers on the current crop has been limited by lack of adequate financial resources. In the irrigated areas a cool spell during the last half of May interfered with the development of the young plants.

The combination of these factors is expected to result in a 1952-53 crop somewhat below the estimated record crop of 130,000 bales (of 500 lb. gross) produced in 1951-52.

The large domestic production of cotton has made Greece virtually self-sufficient in meeting local mill requirements. Imports of raw cotton are restricted to small quantities of special types of the longer staple fibres. During the first eight months of 1951-52, Greece imported 800 bales of cotton, more than 500 bales originating in Egypt, 200 in the United States, and the remainder in the Anglo-Egyptian Sudan.

PAKISTAN

Revised wheat forecast. The revised fourth forecast of the yield of the Pakistan wheat crop for 1951-52 is 3,266,000 tons, against 3,927,000 tons reported in the fourth forecast of the previous year. Actual yield in 1950-51 was 3,953,000 tons. The decrease on last year's fourth estimate is attributed to the decreased acreage planted to wheat and to scarcity of canal water.

The revised fourth forecast of the area under wheat in 1951-52 is 10,397,000 acres, compared with 10,826,000 acres reported in the fourth forecast of the previous year. The acreage decrease was general and was attributed to unfavourable weather conditions, in some areas and an increase of oilseed cultivation in the Sind.—*Reuter.*